



INTERIM MEASURES AIR SPARGING PILOT TEST SUMMARY REPORT

Draft

**Prepared for:
ASARCO Incorporated
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PILOT TEST SUMMARY REPORT

- DRAFT -

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TABLE OF CONTENTS

LIST OF TABLES	iii
LIST OF FIGURES	iii
LIST OF APPENDICES	v
1.0 INTRODUCTION	1-1
1.1 OBJECTIVES	1-2
1.2 SCOPE	1-2
1.2.1 Phase I Pilot Testing Program.....	1-3
1.2.2 Phase II Air Sparge Testing Program	1-3
1.2.3 Phase III Air Sparge Pilot Testing Program.	1-4
2.0 PHASE I PILOT TESTING.....	2-1
2.1 SITING ANALYSIS.....	2-1
2.1.1 Hydrogeology	2-1
2.1.2 Groundwater Flow Conditions.....	2-2
2.2 SYSTEM DESIGN AND INSTALLATION	2-3
2.2.1 Air Sparge Well Design and Installation	2-3
2.2.1.1 Test Well Locations	2-3
2.2.1.2 Test Well Lithology	2-4
2.2.1.3 Test Well Construction and Development.....	2-5
2.2.2 Air Sparge System Design.....	2-6
2.2.2.1 Air Compressor Selection.....	2-6
2.2.2.2 Piping and Instrumentation	2-8
2.3 AIR SPARGE PILOT TEST METHODOLOGY	2-8
2.3.1 System Start-up.....	2-8
2.3.2 Phase I Pilot Test	2-9
2.3.2.1 Operational Parameters	2-10
2.3.2.2 Water Quality Monitoring.....	2-11
2.3.2.3 Sampling Protocol.....	2-12
2.4 PHASE I PILOT TESTING RESULTS	2-13

2.4.1 Pre-test conditions.....	2-13
2.4.2 Phase I Testing At SPAR-1 and SPAR-2.....	2-13
2.4.3 Phase I Testing at SPAR-3.....	2-15
2.4.4 Discussion of Water Quality Results	2-16
3.0 PHASE II BENCH SCALE TESTING	3-1
3.1 BENCH SCALE TESTING PROGRAM.....	3-1
3.2 BENCH SCALE TESTING RESULTS	3-1
4.0 PHASE III AIR SPARGE TESTING PROGRAM	4-1
4.1 MONITORING AND INJECTION WELL INSTALLATION.....	4-2
4.2 SPARGE SYSTEM DESIGN AND OPERATION MODIFICATIONS	4-3
4.2.1 SPAR-3 Startup and Operation.....	4-3
4.2.2 Iron Injection.....	4-4
4.3 PHASE III AIR SPARGE OPERATION RESULTS.....	4-6
4.3.1 Phase III Operational Parameters.....	4-6
4.3.2 Phase III Water Quality Results:.....	4-7
4.3.2.1 SPAR-3 Testing Results	4-7
4.3.2.2 SPAR-1 and SPAR-2 Phase III Testing Results	4-8
STW-7 and STW-8	4-9
5.0 SUMMARY AND RECOMMENDATIONS.....	5-1
5.1 CONCLUSIONS.....	5-1
5.2 RECOMMENDATIONS	5-5
6.0 REFERENCES	6-1

LIST OF TABLES

TABLE 1-1. SUMMARY OF AIR SPARGE TESTING
U:\USER\MILLER\RJMAEHR\FIWORK\SPARGEREREPORT\SPARGE\SPARGESUMMARY.XLS
TABLE 2-1. CONSTRUCTION OF SPARGING WELLS AND MONITORING WELLS
INSTALLED DURING INTERIM MEASURES SPARGING PILOT TEST
U:\USER\MILLER\RJMAEHR\FIWORK\SPARGEREREPORT\SPARGE\SPARCON2.XLS\TABLE 3-1

TABLE 2-2. SPARGING TEST GROUNDWATER SAMPLE COLLECTION AND ANALYSIS

U:\USER\MILLER\RJMAEH\RFIWORK\SPARGEREREPORT\SPARGE\SPARMATX.XLS\TABLE 2-2

TABLE 2-3. PARAMETER LIST

U:\USER\MILLER\RJMAEH\RFIWORK\SPARGEREREPORT\SPARGE\SPARMATX.XLS\TABLE 2-3

TABLE 2-4. BASELINE WATER QUALITY RESULTS

U:\USER\MILLER\RJMAEH\RFIWORK\SPARGEREREPORT\SPARGE\BASELINE.XLS\PHASE I DATA SUMMARY

LIST OF FIGURES

FIGURE 2-1. NOVEMBER/DECEMBER 1999 DISSOLVED ARSENIC CONCENTRATIONS IN SHALLOW GROUNDWATER

TAC\I: LAND PROJECTS\EAST HELENA-04-11-03\EAST HELENA-04-11-03-T001.DWG

FIGURE 2-2. GEOLOGIC CROSS SECTION IN AREA OF SPARGING

TAC\I: LAND PROJECTS\EAST HELENA-04-11-03\EAST HELENA-04-11-03-T008.CDR

FIGURE 2-3. LOCATION OF SPARGE WELLS AND MONITORING WELLS FOR THE AIR SPARGING PILOT TEST PROGRAM

TAC\I: LAND PROJECTS\EAST HELENA-04-11-03\EAST HELENA-04-11-03-T002.DWG

FIGURE 2-4. GEOLOGICAL CROSS-SECTION AT SPARGE WELLS

TAC\I: LAND PROJECTS\EAST HELENA-04-11-03\EAST HELENA-04-11-03-T005.CDR

FIGURE 2-5. WELL CONSTRUCTION AND STRATIGRAPHY FOR SPAR-1 AND 2

TAC\I: LAND PROJECTS\EAST HELENA-04-11-03\EAST HELENA-04-11-03-T006.CDR

FIGURE 2-6. WELL CONSTRUCTION AND STRATIGRAPHY FOR SPAR-3

TAC\I: LAND PROJECTS\EAST HELENA-04-11-03\EAST HELENA-04-11-03-T007.CDR

FIGURE 2-7. TYPICAL SHALLOW MONITORING WELL CONSTRUCTION

TAC\I: LAND PROJECTS\EAST HELENA-04-11-03\EAST HELENA-04-11-03-T003.DWG

FIGURE 2-8. SCHEMATIC LAYOUT OF AIR SPARGE SYSTEM

TAC\I: LAND PROJECTS\EAST HELENA-04-11-03\EAST HELENA-04-11-03-T004.DWG

FIGURE 2-9. SPAR-2 AIRFLOW RESPONSE AT SYSTEM START-UP

K:\PROJECT\1257\RFI-2002\SPARGE\FLOWRATES2.XLS\FIG2-9

FIGURE 2-10. GROUNDWATER RESPONSE AT SYSTEM START-UP

K:\PROJECT\1257\RFI-2002\SPARGE\PRETESTWLDATA.XLS\FIG2-10

FIGURE 2-11. SUMMARY OF AIRFLOW DATA FROM SPARGE PILOT TESTS

K:\PROJECT\1257\RFI-2002\SPARGE\FLOWRATES2.XLS\FIG2-11

FIGURE 2-12. PHASE I SPAR-1 AND 2 PILOT TEST – FIELD PARAMETERS

U:\USER\MILLER\RJM\AEH\RFIWORK\SPARGEREREPORT\SPARGE\LOGBOOK.XLS\PHASE1 SPAR 1&2
FIELD

**FIGURE 2-13. PHASE I SPAR-1 AND 2 PILOT TEST – ARSENIC CONCENTRATION
GRAPHS**

U:\USER\MILLER\RJM\AEH\RFIWORK\SPARGEREREPORT\SPARGE\SPARGGRAPH.XLS\FIG2-13

FIGURE 2-14. PHASE I SPAR-3 PILOT TEST – FIELD PARAMETERS

U:\USER\MILLER\RJM\AEH\RFIWORK\SPARGEREREPORT\SPARGE\LOGBOOK.XLS\FIG2-14

FIGURE 2-15. PHASE I SPAR-3 PILOT TEST – ARSENIC CONCENTRATION GRAPHS

U:\USER\MILLER\RJM\AEH\RFIWORK\SPARGEREREPORT\SPARGE\SPARGGRAPH.XLS\FIG2-15

**FIGURE 2-16. COMPARISON OF ARSENIC TRENDS IN GROUNDWATER PRE AND
POST TESTING**

U:\USER\MILLER\RJM\AEH\RFIWORK\SPARGEREREPORT\SPARGE\SPARGGRAPH.XLS\FIG2-16

**FIGURE 2-17. PHASE I SPAR 1 AND 2 PILOT TEST – AUGUST 16, 2000 – DISSOLVED
OXYGEN ZONE OF INFLUENCE**

u:\user\miller\bjm\aeH\rfiwork\spargereport\sparge\oxygenmap.srf

**FIGURE 2-18. PHASE I SPAR-1 AND 2 PILOT TEST – AUGUST 16, 2000 – ARSENIC
SPECIATION**

U:\USER\MILLER\RJM\AEH\RFIWORK\SPARGEREREPORT\SPARGE\POTMAP3.SRF

FIGURE 4-1. WATER LEVEL TRENDS AT SPAR-3 SPARGE SYSTEM

u:\user\miller\bjm\aeH\rfiwork\spargereport\sparge\waterlevels.xls\dh-24&spar3

**FIGURE 4-2. PHASE III WATER QUALITY TREND GRAPHS FOR SPAR-3
AND DH-24**

U:\USER\MILLER\RJM\AEH\RFIWORK\SPARGEREREPORT\SPARGE\SPARGEGRAPHS2.XLS\2
WELLS-AS,FE

**FIGURE 4-3. PHASE III WATER QUALITY TREND GRAPHS FOR SPAR-3
AND DH-24**

U:\USER\MILLER\RJM\AEH\RFIWORK\SPARGEREREPORT\SPARGE\SPARGEGRAPHS2.XLS\2
WELLS-DO,SO4

**FIGURE 4-4. PHASE III WATER QUALITY TREND GRAPHS FOR SPAR-3 AND DH-
24**

U:\USER\MILLER\RJM\AEH\RFIWORK\SPARGEREREPORT\SPARGE\SPARGEGRAPHS2.XLS\2 WELLS-
AS+3+5,PH

**FIGURE 4-5. WATER LEVEL TRENDS AT UPGRADIENT WELLS AT SPAR-1 AND
SPAR-2 SPARGE SYSTEM**

U:\USER\MILLER\RJM\AEH\RFIWORK\SPARGEREREPORT\SPARGE\WATERLEVELS.XLS\STW-1,2,3,7,8

FIGURE 4-6. WATER LEVEL TRENDS AT DOWNGRAIDENT WELLS AT SPAR-1
AND SPAR-2 SPARGE SYSTEM

U:\USER\MILLER\RJMAEHR\FIWORK\SPARGEREREPORT\SPARGE\WATERLEVELS.XLS\STW-4,5,6,9,DH-50

FIGURE 4-7. PHASE III WATER QUALITY TREND GRAPHS FOR STW-1 THROUGH
6 AND STW-9

U:\USER\MILLER\RJMAEHR\FIWORK\SPARGEREREPORT\SPARGE\SPARGEGRAPHS2.XLS\MULTIWELL-
AS,FE,DO

FIGURE 4-8. PHASE III WATER QUALITY TREND GRAPHS FOR STW-1 THROUGH
6 AND STW-9

U:\USER\MILLER\RJMAEHR\FIWORK\SPARGEREREPORT\SPARGE\SPARGEGRAPHS2.XLS\MULTIWELL
SO4,PH

FIGURE 4-9. PHASE III WATER QUALITY TREND GRAPHS FOR STW-7 AND STW-
8

U:\USER\MILLER\RJMAEHR\FIWORK\SPARGEREREPORT\SPARGE\SPARGEGRAPHS2.XLS\STW7&8,AS,AS
SPEC

FIGURE 4-10. PHASE III WATER QUALITY TREND GRAPHS FOR STW-7 AND STW-
8

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PH

FIGURE 4-11. PHASE III WATER QUALITY TREND GRAPHS FOR STW-1 AND STW-
8

U:\USER\MILLER\RJMAEHR\FIWORK\SPARGEREREPORT\SPARGE\SPARGEGRAPHS2.XLS\STW7&8,O,SO4,
PH

FIGURE 4-12. PHASE III WATER QUALITY TREND GRAPHS FOR STW-1 AND STW-
8

U:\USER\MILLER\RJMAEHR\FIWORK\SPARGEREREPORT\SPARGE\SPARGEGRAPHS2.XLS\STW1&8,AS,AS
SPEC

FIGURE 5-1. SHALLOW AQUIFER MAY/JUNE 2003 ARSENIC
CONCENTRATIONS (RED VALUES) AND JUNE 2004
CONCENTRATIONS (BLUE VALUES) ON MAY 2002 PLUME
MAP

U:\USER\MILLER\RJMAEHR\FIWORK\SPARGEREREPORT\SPARGE\FIG5-1.PPT

LIST OF APPENDICES

- APPENDIX A WELL LITHOLOGIC/CONSTRUCTION LOGS AND WELL DEVELOPMENT LOGS
- APPENDIX B IRON SPECIATION DR2000 SUMMARY
- APPENDIX C ANALYTICAL DATA
- APPENDIX D PHASE II BENCH SCALE TESTING SUMMARY
- APPENDIX E POTENTIOMETRIC SURFACE MAPS FOR THE SPARGE PILOT TEST AREA
- APPENDIX F WATER QUALITY TREND GRAPHS FOR SPAR-3 AND SPAR-1 AND SPAR-2 SPARGE SYSTEMS

INTERIM MEASURES AIR SPARGING PILOT TEST REPORT

1.0 INTRODUCTION

Arsenic has been identified as the primary constituent of concern in groundwater at the Asarco East Helena plant site. Under the Interim Measures (IM) Work Plan (Hydrometrics, 1999), Asarco committed to implementing a series of interim measures designed to address arsenic releases from identified source areas and evaluate migration control measures that could be implemented as interim measures to reduce arsenic migration in groundwater from the plant site.

The IM Work Plan identified in-situ treatment of groundwater through redox controls as a potential measure for control of arsenic migration in shallow groundwater. Water quality data suggest that a portion of the dissolved arsenic in groundwater on the plant site is already being actively attenuated in the shallow groundwater system through co-precipitation/adsorption of arsenic with hydrous iron oxides/hydroxides. The IM Work Plan proposed further evaluation of air sparging as a potential means of controlling the redox state of groundwater and thus further limiting arsenic mobility.

Although testing is required to fully assess the potential feasibility of air sparging for attenuation of arsenic in groundwater at the site, it has a number of potential advantages for implementation as an interim measure. For example, air sparging could be implemented without extensive permitting and it does not require construction of large-scale treatment facilities.

Groundwater capture was also evaluated in the IM Work Plan, but was found to have limited technical feasibility as an interim measure as a result of insufficient treatment capacity at the existing water treatment plant. Extended time would be necessary for development and implementation of the additional treatment facilities needed for groundwater capture at the

site boundary. While groundwater capture will be further evaluated as a potential long-term measure under the RFI, it was not considered feasible in the short-term without available capacity at the existing treatment plant.

The IM Work Plan included a scope of work to evaluate the feasibility and effectiveness of air sparging for control of arsenic migration in groundwater. Under this plan, conventional air sparging technology (injecting air into the groundwater system) was used to increase the oxidation state of groundwater and shift the arsenic redox equilibrium toward dominance by As (V) species. Arsenic is typically less mobile as As (V) than As (III). In addition, dissolved ferrous iron (Fe^{2+}) in groundwater may be oxidized to Fe^{3+} , subsequently precipitating as ferric hydroxide, and potentially binding arsenic either as a co-precipitate or as an adsorbed species.

1.1 OBJECTIVES

The primary objectives of the air sparge pilot tests were to evaluate water quality changes as a result of air sparging, and determine whether this technology has potential application as an interim measure for attenuation of arsenic in shallow groundwater. Goals of the air-sparging test were:

1. To determine if air sparging is capable of changing the arsenic redox state of groundwater and thereby increasing arsenic attenuation within the aquifer.
2. To evaluate whether air sparging is capable of achieving regulatory limits for arsenic in groundwater.
3. To identify potential design parameters for application of air sparging technology at this site.

1.2 SCOPE

Air sparge pilot testing at the East Helena Site was conducted from April 2000 through December 2002. The testing program consisted of three general phases.

1.2.1 Phase I Pilot Testing Program

The Phase I air sparging program was conducted from April 2000 through February 2001 and included the following tasks:

- Siting and design analysis to select locations for test wells and design the sparge pilot scale system. The analysis was based on IM hydrogeological data compiled in the proposed test area and presented in the IM Supplemental Groundwater Report (Hydrometrics, 2000).
- Installation of three sparge pilot scale testing wells at two locations based on a review of the IM hydrogeological data. Two locations were tested rather than one to evaluate the effects of varying geochemical conditions in the plume area. Six additional monitoring wells were also installed to supplement the existing monitoring well coverage for the testing program, and better define the area of influence for the sparge system.
- Documentation of baseline water quality at both air sparge pilot test sites, and at the existing monitoring network prior to air sparge pilot scale testing.
- Performance of air sparge pilot scale tests at two separate locations. The tests were used to evaluate the effectiveness of air sparging in groundwater that had differences in pre-test water quality.

Results of the Phase I testing program were presented in an interim measures testing report (Hydrometrics, 2001a) and are included in this Air Sparge Summary Report (see Section 2).

1.2.2 Phase II Air Sparge Testing Program

Following the completion of the Phase I testing, additional bench-scale testing was conducted from February 2001 through June 2001 to assess the feasibility for the introduction of iron to

the groundwater system in the air sparging area, thereby enhancing arsenic removal. A series of batch tests and column tests were conducted with the following objectives:

1. Assess the solubility of various iron reagents in groundwater from the site.
2. Evaluate iron attenuation by site soils.
3. Evaluate the effect of varying iron concentrations on groundwater pH.
4. Evaluate the effect of iron concentrations and pH on iron/arsenic removal rates.
5. Evaluate time required for iron/arsenic precipitation.
6. Evaluate the stability of arsenic bearing iron precipitates.

Results of the Phase II Bench testing program were presented in an interim measures testing report (Hydrometrics, 2001b) and are included in this Air Sparge Summary Report (see Section 3).

1.2.3 Phase III Air Sparge Pilot Testing Program.

A Phase III pilot was conducted from September 2001 through December 2002. The objectives of this Phase of testing were to provide a more long-term evaluation of sparging, and to test iron introduction methods to enhance removal of arsenic in groundwater during air sparging. This report presents the results of Phase III testing efforts (see Section 4).

All phases of the air sparge testing are summarized Table 1-1 and are discussed below.

2.0 PHASE I PILOT TESTING

2.1 SITING ANALYSIS

A siting analysis was conducted to identify locations with favorable hydrogeologic conditions for pilot testing an air sparge system. Monitoring wells DH-24 and DH-50 were identified as the potential locations for testing, since they lie near the downgradient plant site boundary and are within the north-northeast trending arsenic plume which extends across the plant site boundary (see Figure 2-1). Monitoring well DH-50 is located at the north side of the Asarco plant property and just south of the American Chemet property fence. Monitoring well DH-24 is located about 125 feet west of DH-50 and is also near the boundary between Asarco property and American Chemet property.

Pre-test dissolved arsenic concentrations at DH-24 and DH-50 were approximately 13 mg/L. The hydrogeology of this area was examined to determine optimal locations for the air sparge pilot testing program.

2.1.1 Hydrogeology

Suitable geologic conditions need to be present to apply air sparging effectively. Typical site requirements for air sparging are:

- A minimum of 5 feet of saturated thickness.
- No fine-grained strata inhibiting the upward migration of air to the water table.
- Suitable permeabilities for air injection (1×10^{-3} cm/sec or higher).

Figure 2-2 is a detailed geologic cross-section of the northern plant site area in the vicinity of DH-24 and DH-50. In general, the subsurface stratigraphy was found to consist of a sequence of silty sand and gravel to a depth of approximately 25 feet. From approximately 25 feet to 40 feet, sandier layers were encountered at irregular intervals. Both DH-24 and DH-50 are completed in this sandy interval and existing aquifer testing data exhibit relatively high permeability for these strata.

Aquifer testing results (Asarco Consulting, 2003) indicate DH-24 has the highest hydraulic conductivity (1×10^{-1} cm/sec), while well DH-50 shows a slightly lower hydraulic conductivity (2×10^{-2} cm/sec). Well completion logs show the presence of a fine-grained layer at 35 feet in DH-24; however, available information did not show any indication of fine-grained strata at well DH-50. *★* As a general rule, the deeper the air sparge well can be completed below the water table, the larger the effective radius. During seasonal low water table conditions (which typically occur in April and early May), the geology at DH-24 would provide only a few feet of saturated thickness. Thus, the area near DH-24 was not considered an optimum air sparge test site due to the limited saturated thickness of the sand aquifer and the presence of the underlying fine-grained strata. Because the presence of a fine-grained layer at DH-24 could limit the effective dispersal of oxygen through the shallower saturated strata, the area near DH-50 was selected as the primary air sparge testing site.

*Shows
pore
air
relatively
short
distance*
Although the DH-24 area was not selected for the initial air sparge test because of stratigraphic limitations, existing water quality data indicated a significant difference in water quality from DH-50. DH-24 showed higher concentrations of iron and a slightly lower pH (see Section 2.4). Because these parameters are important factors in groundwater arsenic mobility, the area near DH-24 was included as a second air sparge-testing site.

2.1.2 Groundwater Flow Conditions

*due to
Arsenic
concentrations
per hydro*
Figure 2-3 shows the arsenic plume, configuration, and potentiometric contours for the shallow groundwater system in the vicinity of monitoring well DH-50. The regional groundwater flow direction and the general direction of plume migration is to the north-northwest. However, the 1999 potentiometric data indicated localized variability and suggested there could be a north-northeast flow direction in the immediate vicinity of DH-24 & DH-50. This interpretation is driven largely by the higher observed water levels at DH-24. The water level trends depicted in Figure 2-3 were confirmed by water level measurements in April 2000.

The hydraulic gradient (i) in the vicinity of DH-50 is 0.011. Based on a hydraulic conductivity (K) of 59 ft/day and an assumed porosity (n) of 30%, the average groundwater velocity (v) in the shallow groundwater system is calculated at approximately 2 ft/day ($v = K \cdot i / n$). This is consistent with previous analyses which indicate typical groundwater flow velocities on the order of 1 to 3 ft/day at the site.

Based on the groundwater flow directions and estimated groundwater flow velocities, two locations were selected for air sparge well construction, and six locations were selected for test monitoring wells (see Figure 2-3). As described in Section 2.2.1.2 of this report, it was necessary to construct two air sparge wells (SPAR-1, SPAR-2) at the first test location near monitoring well DH-50 to ensure adequate air distribution based on the site stratigraphy at this location.

2.2 SYSTEM DESIGN AND INSTALLATION

2.2.1 Air Sparge Well Design and Installation

Three air sparging wells (SPAR-1, SPAR-2 and SPAR-3) and six sparge test monitoring wells (STW-1 through STW-6) were constructed for Phase I pilot testing purposes. Air sparging and monitoring well locations are shown on Figure 2-3 and well lithologic and construction logs are in Appendix A.

2.2.1.1 Test Well Locations

Air sparging wells SPAR-1 and SPAR-2 are located approximately 50 feet south of existing monitoring well DH-50. SPAR-3 is located approximately 125 feet to the west of SPAR-1 and SPAR-2 and approximately 25 feet south of monitoring well DH-24.

Monitoring wells (STW-1 through STW-6) were constructed near air sparge wells, SPAR-1 and SPAR-2, to evaluate the effects of air sparging on groundwater quality and determine the effective zone of influence. Well STW-1 is located 75 feet south and hydraulically upgradient of the air sparge wells and was installed to evaluate background water quality. Wells STW-2 through STW-6 are located north of the air sparge wells to evaluate groundwater quality.

hydraulically downgradient of the sparging system. Downgradient monitoring wells were sited to evaluate the anticipated zone of influence from the air sparging system. [A rule of thumb for estimating the potential radius of influence is two times the injection depth (depth below the water table).] A radius of influence of approximately 18 feet was initially anticipated assuming the air sparge well screen was located 9 feet below the water table surface. The actual radius of influence was evaluated during operation of the air sparging system and is described in Section 5.

2.2.1.2 Test Well Lithology

Subsurface soil samples were collected using 2-inch or 3-inch diameter split spoon samplers. Because of problems recovering samples in the beginning of the program due to the abundant gravels, a larger 3-inch diameter sampler proved to be more effective for sample collection. Grab samples were also collected at the ground surface and in some instances from drill rig cuttings (at the discretion of the field geologist.) Borehole samples were examined for lithology, grain size, texture, and color. Following field lithologic analysis, soil samples were archived and are available for any future analytical evaluation.

Since the air sparging wells and test monitoring wells were located relatively close together for pilot testing purposes, it was possible to obtain detailed descriptions of the testing area stratigraphy during the well drilling process. Based on lithologic well logs in Appendix A, detailed stratigraphic cross-sections were prepared (see Figure 2-4). As the cross-sections show, the stratigraphy of the pilot test area generally consists of a heterogeneous mixture of coarse-grained alluvial gravel, sand and cobbles with discontinuous layers of silty sand and occasional discontinuous silty clay layers. These variations in texture appear to be very localized and reflect a highly heterogeneous stratigraphy in the testing area.

As described in Section 2.1.1, the location for the first air sparge test was selected because existing information from Well DH-50 showed the presence of a saturated sand layer without the fine-grained silty clay layers that were noted at DH-24 (see DH-50, Cross Section B-B', Figure 2-4). Although available stratigraphic information did not indicate the presence of

fine-grained strata at monitoring well DH-50 (see Section 2.1.1), a fine-grained silt layer was observed during the drilling of air sparge well SPAR-1. Since the presence of this layer was a cause of the same concerns for the area near DH-24 (i.e., the fine-grained layer could limit the ability to distribute oxygen in shallower saturated coarse-grained strata), a second air sparge well, SPAR-2, was constructed adjacent to SPAR-1. The original design objective for SPAR-2 was to complete the well above the fine-grained layer that was discovered at SPAR-1. However, as shown in Cross Section B-B' (Figure 2-4), even though SPAR-2 is located only about 5 feet to the west of SPAR-1, drill core samples did not show the presence of the fine grained layer noted at SPAR-1. As the cross sections in Figure 2-4 show, this pattern of heterogeneous stratigraphy was also observed during air sparge test monitoring well drilling and sampling.

2.2.1.3 Test Well Construction and Development

Air sparge well completion details are in Figures 2-5 and 2-6 and typical test shallow monitoring well construction details are in Figure 2-7. Similar to past monitoring well construction in the area, the air sparging wells and sparge test monitoring wells were drilled using a Mobile B-61/ODEX drilling rig to allow drilling through cobble and boulder strata that overlie the target completion zone (saturated sand). Previous monitoring well drilling in this area required use of an ODEX or conventional air rotary drilling system due to the presence of coarse gravels and large basalt cobbles.

The sparge wells were constructed using 2-inch flush-threaded schedule 40 polyvinyl chloride (PVC) pipe and two to three foot of factory slotted (0.010 slot) well screen, and were sand packed and grouted to meet Montana monitoring well standards.

The total depth for the air sparge wells ranged from 40 to 41 feet below ground surface (bgs), and the screen interval ranged from 35 to 40 feet bgs. A target depth of 40 feet for the air sparge wells was chosen because the top of the water table was measured at a depth of 31 feet bgs on April 18, 2000 at well DH-50. A depth of 40 feet maximizes the effective amount of

saturated interval above the sparge point. Table 2-1 presents a summary of air sparge well construction details.

Sparge test monitoring wells were also completed with 2-inch schedule 40 PVC casing with flush joints and threaded couplings. Water bearing intervals were screened with 0.010 factory slot screen, and 2-inch schedule 40 casing. Five feet of well screen was set 1-2 feet below the seasonally low water table. The screens and sand packs were not allowed to intersect the water table to prevent pathways that would allow short-circuiting of air to the unsaturated zone.

The sand packs were installed to one foot above the well screen using 10/20 silica sand. The annular seal above the sand pack consisted of 2 to 3 feet of bentonite chips overlain by bentonite grout to ground surface. The sand pack and annular seal were installed as the ODEX casing was incrementally removed from the borehole. Each monitoring well was completed with a steel protective casing and locking lid.

The air sparging wells and monitoring wells were drilled by Hydrometrics using a B-61 mobile drilling rig. Hydrometrics had a licensed Montana monitoring well constructor present during drilling and well construction operations.

Following well completion, piping from the air compressor was connected to the air sparge well with a T-connection to allow access to the well. Details for the aboveground air sparge system design are presented in Section 2.2.2 of this report.

2.2.2 Air Sparge System Design

2.2.2.1 Air Compressor Selection

Potential airflow and air pressure requirements for air sparging were calculated based on site-specific parameters to determine specifications for a compressor. [Recommended airflow requirements are 5 to 10 cfm (cubic feet per minute) per well (WDNR, 1993).] Air pressures

required to achieve these flow rates are a function of the water depth, and aquifer permeability. Calculations are outlined below.

Calculated Air Pressure Required for Air Sparging

$$\text{Pressure of Injection } (P_i) = H_i + P_r$$

where: (H_i) = Depth of Water Column = 8 ft (assumed height of water above screen)

(P_r) = Release pressure due to frictional losses and the capillary resistance of the formation = 2.3 feet of water (1 psi) for every 4 feet of sand (representative value for a medium grained sand - Nyer & Suthersun, 1993)

$$(P_r) = 4.6 \text{ ft}$$

$$P_i = 8 \text{ ft} + 4.6 \text{ ft} = 12.6 \text{ ft } \underline{P_i = 5.5 \text{ psi}}$$

The calculated air pressure necessary for air sparging is 5.5 psi. Actual air pressures will vary depending on the actual geologic conditions and completion depth at the air sparging site. Maximum air pressures were also calculated to identify the upper pressure range where hydraulic fracturing of the formation may occur. These calculations are based on WDNR (1993) design guidelines, which indicate that the pressure should not exceed the weight of the soil column. Maximum air pressure calculations assume a soil particle density of 2.7, a porosity of 40% (conservative estimate) and a 5 psi safety factor to avoid over pressuring the well.

Calculated Maximum Air Pressure

$$\begin{aligned} \text{Weight of Soil} &= 40 \text{ ft} * 2.7 * 0.6 * 62.4 \text{ lbs/ft} \\ &= 404 \text{ lbs/ft}^2 \end{aligned}$$

$$\begin{aligned} \text{Weight of Water} &= (40 - 29.5) \text{ ft} * 0.4 * 62.4 \text{ lbs/ft} \\ &= 262 \text{ lb/ft}^2 \end{aligned}$$

$$\begin{aligned} \text{Total} &= 404 + 262 \\ &= 4306 \text{ lbs/ft}^2 \\ &= 29.9 \text{ psi} \end{aligned}$$

$$\begin{aligned} \text{With safety factor} &= 29.5 - 5 \\ &= \underline{24.5 \text{ psi}} \end{aligned}$$

Based on these results, a Gast 2567, 1.5 HP rotary vane, oil-less compressor was selected. This compressor uses 115 volt single phase power which is available at a power pole on the site. The compressor produces airflow output of up to 21 cfm at 20 psi. This is a sufficient capacity to allow for uncertainty in site conditions and provides a suitable flow and pressure range for operational testing.

2.2.2.2 Piping and Instrumentation

A schematic layout of the air sparge system is shown in Figure 2-8. Two-inch diameter schedule 40 PVC piping was used to connect the air sparge well and the compressor. Airflow to the air sparge well was cycled to maximize diffusion of oxygen in groundwater. A timer was used to cycle the compressor. Injection times were determined based on initial start-up testing by evaluating the time required for maximum water level response in observation wells (described in Section 2.3.1). Other instrumentation included:

- A check valve between the well and compressor to prevent water from surging in the well when the system is shutdown;
- A ball valve to adjust airflow rates;
- A pressure gage; and
- An in-line metered flow restrictor to monitor and control airflow rates.

2.3 AIR SPARGE PILOT TEST METHODOLOGY

2.3.1 System Start-up

An initial start-up evaluation was made after system installation and prior to conducting an extended pilot test. The system was briefly started up to adjust the airflow and monitor the water level response in the groundwater system. Water levels in the outlying wells, and airflow and air pressure in the air sparge system were monitored during this start-up test to evaluate cycling periods for operation of the sparge system.

An air leak developed in a fitting at the SPAR-1 sparge well during start-up testing. As a result, air was injected only through the SPAR-2 sparge well. Airflow monitoring indicated that the SPAR-2 well was capable of injecting air at the desired flow rate of 5 to 10 cfm at acceptable operating pressures (8 to 14 psi). Air pressures gradually increased for the first 20 minutes of the test and flow rates gradually decreased (Figure 2-9). After 20 minutes of operation, pressure rates began to stabilize at approximately 14 psi and airflow rates at 5 cfm (cubic feet per minute). A water level response was observed in all the sparge monitoring wells during start-up testing. Water levels, like airflow rates, stabilized after about 20 minutes of operation (see Figure 2-10). Based on this response, the sparge system was set to cycle at 15-minute intervals. The cycling is designed to minimize the potential for preferential flow paths to become established and maximize dispersion of the air in the groundwater system.

2.3.2 Phase I Pilot Test

The Phase I sparge pilot test began on May 23, 2000 using the SPAR-2 test well. The test was designed to evaluate the influence of sparging on groundwater redox conditions and metals concentrations. On June 15, 2000, SPAR-1 was also put into operation and both SPAR-1 & SPAR-2 were used as sparge wells to increase airflow rates. On June 29, 2000, the air sparge cycling intervals were fine-tuned. Air injection cycles were adjusted to have the system cycle on for 15 minutes and then off for 45 minutes. This was done to evaluate whether shorter injection cycles would still maintain adequate dissolved oxygen levels while minimizing potential disturbances to the physical flow field. Previous investigators and field tests have shown that short injection cycles followed by longer recovery cycles are often more effective. A primary factor for this phenomenon is the change in water permeability of the aquifer as void space is replaced by air during the air sparge process (NWWA, 2000). Longer recovery cycles allow more dispersion into the aquifer and can enhance the effectiveness of oxygenation of the groundwater system.

Testing at SPAR-1 and SPAR-2 was completed on August 9, 2000. A second sparge test was initiated at the SPAR-3 well on the same day. The purpose of this second test was to evaluate the effects of higher ambient iron concentrations on arsenic removal rates. As discussed in

Section 2.1, and in further detail in Section 2.4.1, dissolved iron concentrations are much higher in the vicinity of SPAR-3 and DH-24 compared to the SPAR-1 & 2 area.

2.3.2.1 Operational Parameters

The target air injection rates for the air sparge test were 5 to 10 cfm. The actual air injection rates and injection pressures achieved during the pilot scale tests are shown in Figure 2-11. As indicated in the graphs in Figure 2-11, airflow rates were initially around 7 cfm at the first sparge site and gradually decreased to 5 cfm within a few weeks of operation. Air injection pressures at SPAR-2 increased over this same period from 7 to 13 psi. These rates are within the original design parameters for the system, but slightly lower than the design estimates.

On June 15, 2000, the second sparge well (SPAR-1) was turned on to provide increased airflow. The air injection rates increased to almost 16 cfm with the addition of the second sparge well and sparge injection pressures dropped to 5-7 psi. These flow rates and injection pressures are more consistent with the operational parameters estimated in the original design calculations. The well completion logs (Appendix A) indicate SPAR-1 is completed in a medium-grained sand unit, which is the type of material assumed in the original design analysis. The well log for SPAR-2 shows finer sand in the completion zone.

Some operational data were also collected at the SPAR-3 site. However, the logistics of collecting operational data were more difficult at this site due to the fact that the system needed to be shutdown to sample the SPAR-3 well. As a result, there are less operational data from this test. Airflow pressures and injection rates are shown in Figure 2-11. Airflow at SPAR-3 ranged from 8 to 10 cfm with injection pressures of 8 to 14 psi. SPAR-3 is screened in a silty sand and gravel unit.

The heterogeneous geology in this area may account for the variability in sparge rates, as well as some of the variability in water quality effects at the observation wells. Despite this variability, the sparging produced fairly well distributed effects in the downgradient area.

2.3.2.2 Water Quality Monitoring

Groundwater quality sampling was conducted prior to the test and during air sparging to assess the effects of air sparging on groundwater chemistry, and to estimate the radius of sparging influence. The groundwater sample collection and monitoring plan is summarized in Table 2-2.

Prior to air sparging, all IM and RI/FS monitoring wells were sampled as part of the regular semi-annual monitoring at the plant site during the week of April 25, 2000. The sample analyses included field parameters (F), metals (M), commons ions (C), and arsenic speciation (A) as shown in Table 2-3. All of the newly installed sparge monitoring wells were sampled on May 10, 2000 (after well development) for the same set of monitoring parameters (F, M, C, A). DH-50 and all of the sparge monitoring wells were sampled a second time on May 18, 2000 to provide a second round of pre-test monitoring data for field parameters and metals (F, M).

The monitoring schedule for the Phase I air sparge pilot tests is summarized in Table 2-2 and includes sampling dates. The sampling parameters for SPAR-1 and 2, and SPAR-3 are listed in Table 2-3. Samples were sent to Asarco's Salt Lake City Technical Services laboratory for expedited analysis.

Eleven monitoring rounds were conducted over the 13-week duration of the Phase 1 SPAR-1 and 2 testing program. Wells STW-1, STW-2, STW-3, STW-4, STW-5, STW-6, and STW-7 were monitored during the first three rounds of the SPAR-1 and 2 pilot test program. DH-24, DH-50, and DH-60 were added during the fourth round in order to evaluate the full radius of influence of air sparging. During the fifth through the eighth round, only the original wells (STW-1, STW-2, STW-3, STW-4, STW-5, STW-6 and STW-7) were sampled. The final round of the SPAR-1 and 2 pilot test program included all previously sampled wells with the exception of DH-50 and the addition of SPAR-3.

SPAR-3, DH-24, and EH-60 were monitored during the Phase 1 SPAR-3 pilot test. Monitoring wells from the first air sparge location (see Table 2-2) were also tested periodically to determine post-sparging water quality effects from the SPAR-1 and 2 testing program.

2.3.2.3 Sampling Protocol

The air sparge system was shutdown during well sampling. Sampling was then conducted following the protocol established in the IM work plan with two modifications:

1. Additional purging was performed to minimize the potential for extraneous water quality effects due to potential channeling of air to the sand pack of a well. Airflow may channel through discrete flow paths to the sand pack of a well. In such a case, water in the sand pack may become more oxygenated than in the surrounding aquifer. This is primarily a concern for wells within the immediate zone of influence of the sparge well. For water quality sampling and determination of sparging effects on groundwater chemistry, it was important to ensure that water collected from wells was truly representative of general groundwater conditions (as opposed to conditions within the borehole and associated sandpack). Therefore, purging volumes were calculated based on the estimated quantity of water within both the well and the sandpack. Approximately three borehole volumes (well plus sandpack) of water were removed prior to sampling.
2. Field parameters (specific conductance, temperature, pH and dissolved oxygen) and iron speciation were measured in the field. Iron speciation measurements in groundwater samples (concentrations of Fe^{2+} and Fe^{3+}) were collected using a field-portable HACH DR2000 spectrophotometer. Ferrous iron (Fe^{2+}) and total iron ($\text{Fe}(\text{tot})$) are measured independently, and Fe^{3+} is calculated as the difference between total and ferrous iron, or $[\text{Fe}(\text{tot}) - \text{Fe}^{2+}]$. The analytical procedure for colorimetric iron speciation measurements is detailed in the DR2000 Methods Manual, and is summarized in Appendix B.

2.4 PHASE I PILOT TESTING RESULTS

2.4.1 Pre-test conditions

Field parameters and laboratory analytical results from the pre-test sampling rounds are shown in Table 2-4. Dissolved oxygen (DO) results from pre-test monitoring rounds show DO concentrations in groundwater of approximately 1 mg/L in all of the wells prior to sparging.

Dissolved arsenic concentrations in test wells prior to sparging ranged from 13 mg/L to 50 mg/L, with higher concentrations in upgradient wells and lower concentrations downgradient. Arsenic speciation data showed a ratio of arsenic III (As^{3+}) to arsenic V (As^{5+}) in groundwater between 1 and 10. The wells with higher arsenic concentrations (STW-1 and STW-4) showed higher $\text{As}^{3+}/\text{As}^{5+}$ ratios.

Dissolved iron concentrations were very low to non-detectable in most of the monitoring wells at the first test site (Sparge 1 and Sparge 2) with the exception of STW-4 which had a pre-testing concentration of approximately 0.4 mg/L dissolved iron. Significantly higher iron concentrations were present immediately to the west, in the second test area (SPAR-3 area). Both SPAR-3 and DH-24 showed dissolved iron concentrations of approximately 12 mg/L in pre-test monitoring. In general the higher iron concentrations at these locations are accompanied by slightly lower pH (about $\frac{1}{2}$ to 1 pH unit).

2.4.2 Phase 1 Testing At SPAR-1 and SPAR-2

Air sparging at the first pilot test site (SPAR-2) was initiated on May 23, 2000. Field parameters and laboratory analytical results from the testing are summarized in Figures 2-12 and 2-13. Tabulated results are included in Appendix C.

Following start-up of the sparge system, an immediate increase in dissolved oxygen was observed in the first downgradient row of monitoring wells (see STW-2 and STW-3 in Figure 2-12). This increase in dissolved oxygen was accompanied by a decrease in the $\text{As}^{3+}/\text{As}^{5+}$ ratios (Figure 2-13). However, there was no evidence of a change in dissolved arsenic

concentrations at any of the wells at this point in the test. These results indicate the sparge system was effectively converting As^{3+} to the more oxidized As^{5+} state.

Increases in DO were observed in additional downgradient wells (STW-4, STW-5, STW-6 and DH-50) after approximately 6 weeks of testing. As with the first row of monitoring wells (STW-2 and STW-3), the downgradient wells also showed a corresponding decrease in the $\text{As}^{3+}/\text{As}^{5+}$ ratios, without evidence of a decrease in dissolved arsenic concentrations except at monitoring well STW-4. Concentrations of dissolved iron in this well had started to decrease and there appeared to be a corresponding decrease in dissolved arsenic concentrations.

By the 10th week of testing, dissolved oxygen concentrations in most of the monitoring wells appeared to be stabilizing and virtually all of the wells had significantly lower concentrations of As^{3+} . However, the wells showed no change in dissolved arsenic with the exception of STW-4. Dissolved arsenic in STW-4 decreased approximately 30% from 40 mg/L to 28 mg/L. During this same period, dissolved iron (Fe^{2+}) at STW-4 decreased from 0.7 mg/L to approximately 0.1 mg/L. DH-50 also showed a slight decrease in dissolved arsenic concentrations, from 11 mg/L to 8 mg/L. Dissolved iron concentrations in DH-50 were less than detection throughout the test.

The first pilot test was stopped on August 9, 2000 after 11 weeks. After sparging ended, dissolved oxygen concentrations gradually returned to pre-test levels. $\text{As}^{3+}/\text{As}^{5+}$ ratios, however, remain significantly lower than initial conditions. Dissolved arsenic concentrations at STW-4 returned to near pre-test levels after approximately 8 weeks. However, concentrations remain below pre-test levels despite a slight increase in upgradient concentrations during this same period as evidenced by water quality trends at STW-1.

In summary, the primary water quality change observed during the first pilot test was an increase in DO concentrations in shallow groundwater and oxidation of arsenic from As^{3+} to the As^{5+} state. Significant dissolved arsenic reductions, however, were only observed in STW-4 where iron was initially present in groundwater. A slight decrease in dissolved

arsenic concentrations was also observed at DH-50, the furthest downgradient well. But in this case, iron removal was not a factor since dissolved iron concentrations were below detection at this well. The zone of influence of the sparge system based on these test results is discussed in Section 2.4.4.

2.4.3 Phase I Testing at SPAR-3

Air sparge testing was initiated at the SPAR-3 site approximately 125 feet to the west of the first location, SPAR-1 and SPAR-2, on August 9, 2000. Groundwater at this location has similar dissolved arsenic concentrations to wells at the first sparge site, but significantly higher dissolved iron. Dissolved iron concentrations at SPAR-3 and DH-24 were approximately 12 mg/L prior to testing.

Field parameters and laboratory analytical results from the testing are summarized in Figures 2-14 and 2-15. Tabulated results are included in Appendix C.

Results from the first monitoring round showed only slightly elevated DO at the sparge well (SPAR-3); however, there was a significant decrease in dissolved iron concentrations. The operation of the sparge system was interrupted sometime between the middle and end of August 2000 due to a power surge. The system was restarted on August 31, 2000. After this second start-up, DO showed a sharp increase at SPAR-3 and dissolved iron concentrations dropped to less than 0.5 mg/L. There was also a sharp drop in dissolved arsenic concentrations at the sparge well. Dissolved arsenic concentrations were reduced approximately 90%, decreasing from 25 mg/L to approximately 3 mg/L.

Over the next seven weeks of operation, similar arsenic trends were gradually observed in downgradient well DH-24. Dissolved arsenic appeared to stabilize at concentrations similar to SPAR-3. While a decrease in dissolved iron concentrations (Fe^{+2}) and $\text{As}^{3+}/\text{As}^{5+}$ ratios indicate some increase in the oxidation state of groundwater at DH-24, there was no observable increase in dissolved oxygen.

Downgradient well EH-60, located in East Helena, showed various water quality changes during the test period. However, it was difficult to determine if any of the observed water quality trends at EH-60 were directly related to system operation. In addition, a local City of East Helena water supply pipeline leak on Pacific Street had known water quality effects during this period (Asarco Consulting Inc, 2003). Testing at SPAR-3 was shutdown on November 3, 2000 after nine weeks of operation due to an electrical problem.

2.4.4 Discussion of Water Quality Results

Baseline monitoring results show that under ambient conditions dissolved oxygen (DO) concentrations in groundwater are relatively low, typically about 1 mg/L. Dissolved arsenic is present in groundwater in the sparge area in the form of As^{3+} (arsenite), and As^{5+} (arsenate). Upgradient of the SPAR-3 test site, As^{3+} (the more reduced form of arsenic) is the dominant species. However, the oxidized form of arsenic, As^{5+} , gradually becomes dominant as groundwater flows downgradient. Correspondingly, pe values (oxidation/reduction potential) for groundwater calculated from $\text{As}^{3+}/\text{As}^{5+}$ ratios increase as groundwater flows downgradient. These trends in groundwater chemistry between STW-1 and DH-50 (see Figure 2-16) indicate that groundwater is undergoing a change in redox state in this area even prior to sparging. Figure 2-16 also shows a decrease in overall dissolved arsenic concentrations along this flow path (from 46 mg/L at STW-1 to 11 mg/L at DH-50). The concurrent decline in dissolved arsenic concentrations with increase in oxidation state of groundwater pe suggest a relationship between arsenic attenuation and redox state.

Although arsenic co-precipitation with iron hydroxides is believed to be a significant factor in arsenic attenuation in groundwater on portions of the plant site, groundwater in the vicinity of these wells has little or no detectable iron. The primary mechanism for arsenic removal may be adsorption of arsenic to iron oxides in the aquifer or other mineral surfaces. Typically arsenic is more readily adsorbed as arsenate than as arsenite; therefore, the purpose of air sparge testing in this area was to examine whether increasing DO concentrations in groundwater could oxidize arsenic to the more readily attenuated form.

As previously discussed in Section 2.4, dissolved iron concentrations in groundwater are significantly higher and pH values are lower in the SPAR-3 area immediately to the west of the first SPAR-1 and SPAR-2 test site. Measurements confirm that essentially all of the dissolved iron is present in groundwater as the reduced form of iron, ferrous iron (Fe^{2+}). Upon oxidation to ferric iron (Fe^{3+}), iron becomes very insoluble and iron oxides/hydroxides typically precipitate and are removed from solution. Because of the presence of ferrous iron in groundwater in this area, arsenic may be amenable to removal by co-precipitation of arsenic with iron oxides/hydroxides under the proper redox conditions. Prior to testing, there was little evidence of active iron removal in the immediate area of the air sparge wells. The SPAR-3 air sparge pilot test examined whether increasing DO concentrations in groundwater would effectively remove iron and result in higher arsenic attenuation rates as a result of arsenic co-precipitation with iron.

Data collected during the air sparge tests were examined to evaluate the following issues:

1. The amount and extent of DO effects in the shallow groundwater system.
2. Whether increasing the DO effectively changed the redox state of iron and arsenic.
3. Effects of increased DO and redox on dissolved arsenic and iron concentrations.
4. Post-operational water quality changes.

Air sparging test results clearly indicate that sparging was effective at introducing DO into the shallow groundwater system at the sparging wells and in surrounding groundwater. Prior to sparging, DO concentrations in all wells were approximately 1 mg/L. Soon after the start of sparging, DO concentrations increased to near saturation levels (8 to 12 mg/L) in groundwater in the immediate vicinity of the sparge wells. At the SPAR-1 & 2 test site where monitoring wells were fairly closely spaced, the test data show a 20 foot wide zone of increased dissolved oxygen (at 2-3 mg/L) extending downgradient of the sparge wells (Figure 2-17). In contrast, no DO changes were evident in downgradient well DH-24 at the SPAR-3 test site. Since changes in arsenic speciation and dissolved arsenic were evident at DH-24, it is likely that the oxygen was consumed in redox reactions before reaching DH-24.

Sparging test results clearly demonstrate that increasing the DO content of groundwater by sparging causes oxidation of arsenic in groundwater. As indicated, both test sites showed a change in arsenic speciation from dominantly As^{3+} prior to the test, to dominantly As^{5+} during and for a time after the test. This redox change was most evident at the first test site (SPAR-1&2) where virtually all of the arsenic in all of the wells was converted to As^{5+} by the end of the test (see Figure 2-18). The area showing redox changes (as defined by an arsenic speciation change) was considerably wider than the DO plume (see Figure 2-17).

Arsenic speciation changes were also evident in the sparge well at the second test site (SPAR-3) where the $\text{As}^{3+}/\text{As}^{5+}$ ratio decreased approximately 10,000 fold. There are not enough wells at SPAR-3 to define the areal extent of redox changes in downgradient groundwater. However, it may be somewhat smaller in the SPAR-3 area since more oxygen is being consumed in redox reactions with iron. This appears to be the case at DH-24 where redox changes are less pronounced than wells at similar distances near the SPAR-1& 2 test site.

Increasing DO contents and oxidation of arsenic in groundwater only produced an appreciable reduction in dissolved arsenic concentrations at wells where dissolved iron was initially present in groundwater. At the first test site, dissolved iron concentrations were low ($< 1 \text{ mg/L}$) throughout the test and dissolved arsenic decreases were modest (approximately 0 to 40 percent) in all wells. At the second test site, dissolved iron concentrations were higher (12 mg/L) prior to the test and dissolved arsenic decreases during the test were higher (up to 91 percent in the sparge well). While arsenic removal was greatly enhanced by sparging in the presence of iron, the concentrations of dissolved arsenic remaining in groundwater still exceed water quality standards. Arsenic removal at SPAR-3 appeared to be limited by depletion of dissolved iron in groundwater. Further reductions in dissolved arsenic concentrations by sparging may be possible if the initial concentrations of dissolved iron in groundwater are increased.

The rapid change in iron and arsenic concentrations with increases in DO is characteristic of co-precipitation of arsenic with iron hydroxides. The amount of arsenic removal observed during the tests, however, cannot be accounted for exclusively by iron-arsenate precipitation reactions. Assuming that iron and arsenic are oxidized by the sparge system, and are thus present as Fe^{3+} and H_2AsO_4^- immediately downgradient of the sparge system, any precipitation of iron-arsenic solids would likely form compounds such as $\text{FeAsO}_4 \cdot 2\text{H}_2\text{O}$ (Scorodite). The stoichiometric formation of this mineral would result in removal of iron and arsenic from solution at a mass ratio of about 0.74 (i.e., the ratio of iron removed in mg/L to arsenic removed in mg/L). Calculation of removal ratios at wells STW-4 and SPAR-3, where iron and arsenic removal from groundwater has been observed, results in ratios of 0.03 at STW-4 and 0.45 at SPAR-3. The amount of arsenic removed at these wells is, therefore, greater than can be accounted for by a simple iron arsenate precipitation reaction. The additional arsenic removal is likely through incorporation in other compounds (entrapment within iron oxides) or adsorption to iron oxides or other surfaces.

Monitoring data collected at the first test site (SPAR-1 and SPAR-2) after the cessation of sparging indicate that the majority of sparging effects are temporary and of moderate duration. Dissolved oxygen concentrations generally had decreased to background levels (about 1 mg/L) within approximately two months after sparging ceased. Ratios of $\text{As}^{3+}/\text{As}^{5+}$ in groundwater also increased after sparging ceased, indicating a return to more reducing conditions in groundwater. The increases in $\text{As}^{3+}/\text{As}^{5+}$ ratios, however, are slower than would be expected based on the changes in DO concentrations.

Three months after sparging ceased, $\text{As}^{3+}/\text{As}^{5+}$ ratios in groundwater remained lower (more oxidized) than pre-sparging conditions. Corresponding with the return of DO concentrations and $\text{As}^{3+}/\text{As}^{5+}$ ratios to pre-sparging conditions, arsenic concentrations have also increased to near pre-sparging conditions. In particular, post-sparging data from STW-4 show a gradual return of arsenic to near pre-test concentrations in the three-month period following the test.

It is difficult to establish the extent to which the increase in groundwater arsenic concentrations results from remobilization of arsenic. The increase in arsenic concentration may simply be due to flow of untreated water back into the area from up-gradient sources. The timing of post-operational water quality changes is consistent with groundwater flow rates of approximately 2 feet per day. Dissolution experiments suggest that only a small fraction of the iron-arsenic precipitates will dissolve back into the solution. Adsorbed arsenic may be more susceptible to remobilization, particularly if there are changes in pH or redox conditions.

3.0 PHASE II BENCH SCALE TESTING

3.1 BENCH SCALE TESTING PROGRAM

Bench scale testing was conducted to evaluate potential methods for introducing iron and optimal concentrations for treatment. Typical reagents used to treat arsenic include ferric and ferrous salts such as ferric chloride and ferrous sulfate. Bench scale tests were conducted to assess alternate iron sources and Fe:As ratios for optimal arsenic removal. Bench scale tests were also used to better evaluate relative reaction rates and how they may influence injection scenarios.

A series of batch tests and column tests were conducted with the following objectives:

1. Assess the solubility of various iron reagents in groundwater from the site.
2. Evaluate iron attenuation by site soils.
3. Evaluate the effect of varying iron concentrations on groundwater pH.
4. Evaluate the effect of iron concentrations and pH on iron/arsenic removal rates.
5. Evaluate time required for iron/arsenic precipitation.
6. Evaluate the stability of arsenic-bearing iron precipitates.

3.2 BENCH SCALE TESTING RESULTS

The Phase II Bench-Scale Testing results are in Appendix D. Table 1 of Appendix D presents a summary of the bench-scale test results, including a brief summary of the objectives, procedures, results and conclusions for each test. Additional tables and graphs are attached in Appendix D presenting supporting data. The bench scale test showed that:

1. Ferrous sulfate appears to be an acceptable reagent. It is soluble in groundwater with only small amounts of iron precipitating after initial dilution in groundwater. Adding a small amount of reducing agent (sodium hydrosulfite) helped reduce precipitates that might eventually result in plugging of the injection well.

2. The site soils have a high iron adsorption capacity under ambient redox conditions. This will slow the dispersion of any introduced iron into the groundwater system. Low pH reduces iron attenuation rates (i.e., iron becomes more mobile as pH decreases).
3. Reagent dosages to yield iron concentrations of 200 mg/L or greater began to significantly decrease the pH of the mixed reagent/groundwater solution (pH<6).
4. 10% to 90% of arsenic was removed during sparging when dissolved iron was added to groundwater. This was similar to field results from Phase I testing. Higher initial iron concentrations produced lower arsenic concentrations after sparging. However, iron concentrations higher than 200 mg/L depressed the pH and resulted in a decrease in the rate of arsenic removal.
5. Reaction rates were relatively rapid. Increases in the duration of air sparging beyond 24 hours produced only minor additional arsenic removal.
6. When soil from a test column was leached, approximately 12% of the adsorbed arsenic was remobilized.

Based on these results, it was concluded that injection of ferrous sulfate followed by air sparging may produce desirable results. However, pH effects and attenuation of iron in the soils will need to be considered.

4.0 PHASE III AIR SPARGE TESTING PROGRAM

The Phase III Pilot Test program was developed and implemented to further evaluate the potential of air sparging as a control interim measure for arsenic migration. Development of this program was based on the data collected as part of Phase I (air sparging field tests) and Phase II (bench scale tests), review of relevant literature, and consultation with EPA technical personnel. General elements of the Phase III program consisted of the pulse operation of sparge wells SPAR-1, SPAR-2 and SPAR-3 and the introduction of dissolved iron into the shallow aquifer. This program consist of the following general steps.

1. Optimization of air sparging operational parameters through examination of Phase I Pilot Test Data.
2. Review of air and water permeability characteristics, and evaluation of design alternatives. Phase I data suggested the effectiveness of oxygen distribution could be enhanced by well spacing optimization and screen placement design. Effectiveness may also be improved by a longer pulsing approach that allows more "down time" for a more complete recovery of the aquifer from physical effects of air sparging (elevated water levels and reduced aqueous permeability).
3. Development of iron introduction methods into the groundwater system to test the potential effectiveness to enhance arsenic removal. Existing data suggest an approach that consists of the introduction of dissolved iron into the shallow aquifer upgradient of the present sparge sites could result in enhanced removal of arsenic during air sparging. The development of iron introduction methods considered:
 - Bench scale testing results to evaluate potential methods for introducing iron and optimal concentrations for treatment.
 - Evaluation of geochemical effects of iron introduction into the aquifer system. Of particular concern is the potential for chemical precipitation and plugging of well screens before the iron can be distributed through the aquifer system.

- Evaluation of the transport of dissolved iron once it was introduced in the subsurface aquifer. This evaluation included the use of groundwater flow and transport routines to simulate the transport of an artificial iron plume to the sparge system. The evaluation also considered the use of additional air or water injection points up-gradient of the sparge test area to route the artificial iron plume to the sparge testing area.
4. Development of the Phase III monitoring well design spacing, completion, and testing analytical parameters. This development included:
- Installation of an iron injection point (STW-7)
 - Installation of additional monitoring wells (STW-8 and STW-9) downgradient of the iron introduction point (STW-7) to evaluate the geochemical effects of introduced iron in the aquifer, and to establish transport rates and direction to the SPAR-1 and 2 testing area.

4.1 MONITORING AND INJECTION WELL INSTALLATION

One iron injection point well (STW-7) and two sparge test monitoring wells (STW-8, and STW-9) were constructed as part of Phase III testing purposes. The location of these three wells is show on Figure 2-3 and well lithologic and construction logs are in Appendix A.

Iron injection point well STW-7 is located approximately 33 feet north of monitoring well STW-1. Monitoring well STW-8 is located approximately 30 feet north of STW-7 and approximately 12 feet south of sparging well SPAR-1. Monitoring well STW-9 is located approximately 35 feet north of sparging well SPAR-2. Monitoring wells STW-8 and STW-9 were constructed hydraulically downgradient of the iron injection point well STW-7 to evaluate the geochemical effects of iron injection on downgradient water quality.

Similar to past monitoring well construction, the sparge test monitoring wells were drilled using a Mobile B-61/ODEX drilling rig to allow drilling through cobble and boulder strata that over lie the target completion zone (saturated sand). Subsurface soil samples were

collected as grab samples and by using a 3-inch diameter split spoon sampler. Borehole samples were examined for lithology, grain size, texture, and color.

The injection point well and sparge test monitoring wells were constructed using 2-inch flush-threaded schedule 40 polyvinyl chloride (PVC) pipe, factory slotted (0.020 slot) well screen, and were sand packed and grouted to meet Montana monitoring well standards. Typical test monitoring well construction details are shown in Figure 2-7.

Total drilling depth for the injection well STW-7 was 40 feet. STW-7 was completed across the water table with 15 feet of well screen from 25 to 40 feet bgs. Monitoring wells STW-7 and STW-8 were also drilled to a total depth of 40 feet and were screened from 35 to 40 feet bgs. Five feet of well screen was set several feet below the water table for wells STW-8 and STW-9. Table 2-1 presents a summary of construction details for all sparge test wells.

4.2 SPARGE SYSTEM DESIGN AND OPERATION MODIFICATIONS

4.2.1 SPAR-3 Startup and Operation

Phase III air sparging pilot testing was initiated October 11, 2001 (see Table 1-1). Phase III testing included concurrent sparge operation of the SPAR-1 & 2 system, and the SPAR-3 system. The purpose of concurrent operation was to evaluate long-term groundwater chemistry changes at SPAR-3 where ambient dissolved iron was present in groundwater, relative to the long-term effectiveness at SPAR-1&2 where ambient dissolved iron was lacking and where iron concentrations may be enhanced by the injection of iron into the groundwater system.

In order to facilitate concurrent sparge testing operations, a duplicate compressor was installed for the SPAR-3 system. Both compressors were identical and were a Gast 2567, 1.5 HP rotary vane, oil-less compressor. Contrary to Phase I testing, both compressors were re-wired to run on 230 volts which allowed more efficient use of electrical power. Air flow of both compressors were run at flow rates of 5 to 10 cfm at 8 to 14 psi. For Phase III testing, the system was set to run a 15 minute injection cycle followed by a 1 hour/45 minute off-

cycle. Based on review of Phase I data and other sparge efforts in the literature, longer off-cycle time was expected to minimize the potential for preferential flow paths to become established and allow a good dispersion of the air in the groundwater system.

4.2.2 Iron Injection

Prior to the introduction of iron up-gradient of the SPAR-1 & SPAR-2 test site area, air-sparging was continued for 47 days (to achieve steady-state conditions) prior to the first iron injection on November 27, 2001 (see Table 1-1). A batch injection approach was selected because transport modeling showed a strong potential for adsorption of iron on the existing soil matrix with only limited mobility of iron. As a result, a batch dose approach followed by a fresh-water slug was selected as the injection procedure to rapidly introduce and disperse iron in the groundwater system before adsorption and precipitation of iron at the injection point could occur.

The initial injection was conducted using ferric sulfate as the iron source. The injection procedure consisted of the following:

- 200 gallons of groundwater was pumped from up-gradient well STW-1 (see Figure 2-3) into a mixing tank.
- A designed 2,500 mg/L iron solution was prepared by adding 77.6 grams of sodium hydrosulfite (for oxygen reduction) and 20.76 pounds of ferric sulfate to the 200 gallons taken from STW-1. Verification sampling of the prepared iron solution was conducted and the post-preparation iron concentration was measured to be 2,460 mg/L.
- An additional 200 gallons from STW-1 was pumped into a “clean” tank, to be used as a ‘freshwater flush’ following introduction of the iron solution. A total of 77.6 grams of sodium hydrosulfite was added to the 200 gallons for oxygen reduction.

- The prepared iron solution was introduced into test well STW-7 by gravity feed through a ½ inch flexible line. The flexible line was inserted into the injection well to the screen zone.
- The injected iron solution was immediately followed by the 200 gallon freshwater flush into STW-7.
- A groundwater sample from down-gradient well STW-8 was collected immediately after injection was completed.

Following introduction of iron on November 27, 2001, water quality sampling at the SPAR-1 &-2 site was performed approximately daily until December 7, 2001. A second injection event was conducted on February 11, 2002 using the same general reagent solution preparation and injection procedures as the November event with the following modifications:

1. The target reagent solution was increased to approximately 3000 mg/L iron. This solution was prepared using 25 pounds of ferrous sulfate instead of ferric sulfate.
2. The 'freshwater flush' was reduced to from 200 gallons to 50 gallons.
3. Sodium hydrosulfite was not added to the 'freshwater flush' and was reduced from 77.6 grams to 40 grams for the iron solution.

These modifications allowed for more iron to be introduced into the aquifer and allowed for a higher concentration of iron to affect approximately the same amount of groundwater. Sampling was conducted daily at the SPAR-1 &-2 site between February 12th & 15th, 2002 for a total of four sampling events.

Air sparge operations and groundwater sampling were continued throughout 2002 to monitor long-term effects of iron injection and sparge operations (see Table 1-1). During this period, several additional iron injection events were conducted. These include:

- Weekly iron injection from July 17 through August 14, 2002.
- Bi-weekly (every 2 weeks) iron injection program September 5 through October 4, 2002.
- Weekly iron injection from October 17 to October 31, 2002.

Modifications to the injection schedule were made based on aquifer responses to iron injection and measured iron and arsenic concentrations in downgradient monitoring wells. This testing program allowed evaluation of the effectiveness and feasibility of iron injection to augment arsenic removal from groundwater by air sparging.

Sparging operation and monitoring for the SPAR-1 & -2 system and the SPAR-3 system continued until December 17, 2002. A final sparge sampling event was conducted January 14, 2003 to monitor response to termination of Sparge operations in December 2002.

4.3 PHASE III AIR SPARGE OPERATION RESULTS

4.3.1 Phase III Operational Parameters

As described in Section 2.3.2.1, target air injection rates for the phase III air sparge testing program were 5 to 10 cfm. Actual air injection rates and air injection pressures achieved during the Phase III program are shown in Figure 2-11.

Operating air injection rates for the SPAR-3 testing program ranged from 4 to 10 cfm but were typically within the 5 to 10 cfm target range. However, operating air injection rates for SPAR-1 and 2 were more variable and were similar to conditions observed during the Phase I testing program. Operating air injection rates ranged from 5 cfm to 16 cfm. As described in Section 2.3.2.1, the more variable operating air injection rates for the SPAR-1 and 2 testing

area may be related to the more heterogeneous geology of this area as compared to the SPAR-3 area.

Water level trends associated with periods previous and during the testing program are shown in Figures 4-1, 4-5 and 4-6. Potentiometric maps for the Sparge testing area are in Appendix E. All monitored wells (including SPAR-3) showed very similar seasonal trends, with few observed discrepancies that could be attributed to effects from sparging operations. While temporary water level effects associated with the sparging operation were observed in the field, long-term trends appear to be more a reflection of seasonal declines and increases.

4.3.2 Phase III Water Quality Results:

4.3.2.1 SPAR-3 Testing Results

The sparge testing program water quality data base is in Appendix C and water quality trend plots are in Appendix F. Water quality trend plots during SPAR-3 testing are also summarized in Figures 4-2, 4-3 and 4-4.

The Phase III SPAR-3 testing program showed similar results to that observed during the limited Phase I testing program. Dissolved arsenic and iron concentrations showed a significant drop in both the SPAR-3 well and downgradient well DH-24 shortly after initiation of both Phase I and Phase III air sparging testing program. During Phase III testing, SPAR-3 arsenic concentrations dropped from 23 mg/l to a low of 0.95 mg/l. Dissolved iron concentrations declined from 10 mg/l to a low of 0.02 mg/l during the testing program. DH-24 dissolved arsenic concentrations declined from 17 mg/l to a one time low of 0.08 mg/l, but generally remained at about 1 mg/l through out the test. Similarly, dissolved iron concentrations at DH-24 declined from 9.1 mg/l to 0.027 mg/l during the test.

Concurrent with arsenic and iron concentration declines, DO concentrations increased significantly (0.03 mg/l to 9.5 mg/l) in SPAR-3 shortly after initiation of the test. DO concentrations remained elevated throughout the testing program; although a decline in DO concentrations was observed (from a high of 10.9 to a low of 4.9 mg/l) that roughly

corresponded to a decline in airflow rates during the same period (see Figure 2-11). DO concentration increases (0.21 mg/l to a high of 2.75 mg/l) were also observed in down-gradient well DH-24, but to a less extent than that observed at SPAR-3. Decreases in DO concentration during the testing program resulted in correspondently minor increases in dissolved arsenic concentration.

As noted with earlier testing phases, the ratio of As^{+3}/As^{+5} at both SPAR-3 and DH-24 also decreased significantly during the Phase III testing program. This corresponded with increases in DO concentrations and resulted in decreased dissolved arsenic concentrations.

Sulfate concentrations at both SPAR-3 and DH-24 showed an increase throughout the Phase III testing program. The significance of this increase is unknown since the monitored up-gradient well (STW-1, see Appendix F) also showed an increasing sulfate trend during the testing program. Post-sparging trends for SPAR-3, DH-24, and for up-gradient well STW-1 suggest a decreasing sulfate concentration trend after sparging was completed, but the data are variable and this trend is not completely clear.

Post-Phase III testing monitoring showed a gradual return to near pre-test conditions, with gradual increases in dissolved arsenic, dissolved iron, As^{+3}/As^{+5} ratios, and corresponding decreases in DO concentrations. A total of 17 months after air sparge system shutdown (May 2004), dissolved arsenic concentrations for SPAR-3 and DH-24 were 25 and 22 mg/l, respectively, dissolved iron concentrations for SPAR-3 and DH-24 were 13.4 mg/l and 10.8 mg/l, respectively; while May 2004 DO concentrations had decreased to 0.08 mg/l and 0.014 mg/l, respectively.

4.3.2.2 SPAR-1 and SPAR-2 Phase III Testing Results

The SPAR-1 and SPAR-2 testing water quality trend plots are in Appendix F and are summarized in Figures 4-7 through 4-12. As described in Section 2.4.4 above, the Phase I Sparge testing program for using SPAR-1 and SPAR-2 showed some success in changing groundwater redox conditions and resulted in some reduction of dissolved arsenic.

concentrations. However, concentration decreases were not as large as decreases observed in the SPAR-3 area, where ambient dissolved iron concentrations were significantly higher, and the resulting effectiveness of arsenic removal during sparge testing was correspondingly higher. As a result, the Phase III testing program for the SPAR-1 and SPAR-2 site focused on the potential of iron injection to improve dissolved arsenic removal during air sparging.

STW-7 and STW-8

Water quality trends for iron injection well STW-7 and the next down-gradient well STW-8 are shown in Appendix F and in Figures 4-9 through 4-12. Injection well STW-7 shows significant declines in dissolved arsenic corresponding with iron injection events. As described in Table 1-1, iron was injected 11/27/01, 2/11/02, and weekly or biweekly from 7/17/02 through 10/31/02. Dissolved arsenic concentrations declined from about 30 mg/l prior to injection to a low of 0.045 mg/l when weekly or biweekly injection was conducted. Iron concentrations in the injection well ranged from lows of 0.02 mg/l between injection events to a high of 951 mg/l, but typically ranged between 100 mg/l and 800 mg/l during weekly or biweekly injection.

DO concentrations were variable and showed the effect of air sparge operation. However, DO concentrations were generally lower during weekly or biweekly iron injection events (typically 1 to 6 mg/l).

As⁺³/As⁺⁵ concentration ratios in STW-7 were variable during the Phase III testing but were generally low, as expected during weekly or biweekly sampling periods. This corresponded with the lowest dissolved arsenic concentrations.

Sulfate concentrations down-gradient of iron injection well STW-7 were generally elevated, particularly in response to iron injection periods at STW-7. During weekly or biweekly injection, sulfate concentrations were typically 1000 to 3500 mg/l.

Monitoring well STW-8 is located about 30 feet down-gradient of injection well STW-7. STW-8 showed little response to the 11/27/01 and 2/11/02 iron injection events. Dissolved arsenic concentration declines for these events were from 29 mg/l to 24 mg/l, and from 30 mg/l to 23 mg/l, respectively. Little change in arsenic concentrations were observed in STW-8 between the decline from the 2/11/02 injection event to the beginning of the weekly or biweekly injection period (7/17/02 through 10/31/02). Dissolved iron concentrations at STW-8 during the post 2/11/02 injection period remained low at about 0.02 mg/l, showing little or no evidence of iron migration to STW-8 from injection well STW-7.

However, arsenic decreases were more significant during the weekly/biweekly injection period. Dissolved arsenic concentrations declined from 23 mg/l to a low of 6.7 mg/l. The arsenic concentration low corresponded with a peak dissolved iron concentration of 13 mg/l on 8/22/02. However iron concentrations in STW-8 were typically lower after this date and generally ranged between 0.02 mg/l and 2 mg/l during the remaining iron injection period. Corresponding dissolved arsenic concentrations during this period generally ranged between 11 and 14 mg/l.

Dissolved oxygen concentrations showed effects from the sparging well with somewhat elevated DO concentrations ranging from about 3 to 5 mg/l. This compares with pre-testing DO concentrations ranging from 0.13 mg/l to 1.4 mg/l.

Arsenic $\text{As}^{+3}/\text{As}^{+5}$ ratios were variable in STW-8 but were correspondingly lowest with lowest dissolved arsenic concentrations. Sulfate concentrations were generally elevated during the testing period ranging from a test low of about 700 mg/l to about 1300 mg/l. Concentrations of pH showed some response to the weekly/biweekly injection period with lower pH (5.5 to 6.5) values during this period.

Post testing data (see Appendix F) shows STW-8 dissolved arsenic concentrations increased somewhat, but did not attain pre-concentration results (23 mg/l). Post-testing dissolved arsenic concentrations ranged from a high of 17 mg/l in January and June 2003 to 10 mg/l in

Spring 2004. Paradoxically, dissolved iron and dissolved oxygen remain low; although the Spring 2004 did show a reduction in the $\text{As}^{+3}/\text{As}^{+5}$ concentration ratio from measurements collected during 2003.

STW-1, STW-2, STW-3, STW-4, STW-5, STW-6, and STW-9

Water quality trends for SPAR-1 and 2 area monitoring wells are shown in Appendix F and in Figures 4-7 and 4-8. Up-gradient monitoring well STW-1 continues to show a generally declining trend in arsenic concentrations that began in fall 2000, continued through the Phase III testing period, and generally continued to decline in the post-testing period through May 2004 (see STW-1 – Appendix F). Arsenic concentrations during this period range from a high of 55 mg/l in October 2000 to a low of 17.6 mg/l in May 2004. This arsenic concentration trend roughly corresponds with a mildly increasing iron concentration trend starting November 2001 and continuing through the post-testing period through May 2004. Iron concentrations have generally increased from 0.21 mg/l in September 2001 to 0.5 mg/l in May 2004. DO concentrations have been variable with a low of 0.03 mg/l to a high of 0.89 mg/l and concluding at 0.2 mg/l during the testing period. Post-testing DO has also been variable but generally low with the most recent reading in May 2004 of 0.26 mg/l. $\text{As}^{+3}/\text{As}^{+5}$ concentration ratios have remained high, reflecting the mobile form of arsenic at the East Helena site. Sulfate concentrations and pH have also been mildly variable during the testing and post-testing period with no obvious trends.

Monitoring wells STW-2, and STW-3, STW-4, STW-5, STW-6 and STW-9 show very similar water arsenic concentration trends to that of up-gradient monitoring well STW-1. Arsenic concentrations of most monitoring wells showed a declining trend during the testing period. Monitoring well STW-4, which has a post-testing monitoring record, also continued to show a declining trend after the test was completed.

Dissolved oxygen concentrations in monitoring wells STW-2, STW-3, STW-4, STW-5, STW-6 and STW-9 all show an increase coincident in time with the operation of the Phase III sparge testing period. With the exception of STW-4, these wells showed a rise in DO.

concentrations from less than 0.5 mg/l to a typical range of 5 to 10 mg/l during air sparging operation. STW-4 also showed an increasing trend after Phase III pilot test startup; however, the increase was significantly less with a high of about 1.5 mg/l. Post testing DO concentrations at STW-4 have declined with a DO concentration of 0.29 measured in May 2004.

As^{+3}/As^{+5} ratios for STW-2, and STW-3, STW-4, STW-5, STW-6 and STW-9 were typically high before the start of the test (As^{+3} typically higher than As^{+5}). The As^{+3}/As^{+5} were typically low (As^{+5} typically higher than As^{+3}) after test startup until July measurements when the ratios “flipped” and As^{+3} again became higher than As^{+5} concentrations. The reason for the increase in As^{+3} and decrease in As^{+5} is not clearly understood; however it is coincident in time with the start of the weekly/biweekly iron injection period. Monitoring wells STW-2, and STW-3, STW-4, STW-5, STW-6 and STW-9 also show a mild increase in sulfate during this period and may be showing a response to increased sulfate concentrations associated with the injection of iron during this period. Post-testing monitoring at STW-4 shows a general trend of lower sulfate concentrations since the shutdown of the pilot test program; this corresponds with a reversal of the As^{+3}/As^{+5} ratios with As^{+5} again becoming the dominant species. This also corresponds with a gradually lowering pH from about 6.47 during the test to 6.23 measured during May 2004.

5.0 SUMMARY AND RECOMMENDATIONS

In accordance with the IM Work Plan (Hydrometrics 1999), air sparging techniques were evaluated as a potential interim measure for control of arsenic migration in groundwater. Pre-testing data, collected during previous investigation efforts, suggest arsenic removal from groundwater occurs through co-precipitation/adsorption with hydrous iron oxides/hydroxides where dissolved iron is present and there is an increased oxidation state. Phase I air sparging pilot tests were conducted to evaluate if introducing oxygen to the shallow groundwater system using air sparging techniques can augment natural attenuation processes and limit off-site migration of arsenic in groundwater. This testing program showed air sparging resulted in enhanced reduction of arsenic in groundwater, but the data showed that sparging was more effective where iron was also present in groundwater. Following preparation of an interim report, (Hydrometrics 2001a), additional bench scale tests (Phase II) were conducted and the results were reported concurrent with a plan for additional Phase III air sparge testing (Hydrometrics 2001b).

The Phase III Pilot Test Program was conducted to optimize air sparging operational parameters, evaluate the effects of existing iron in groundwater on the effectiveness of air sparging for removal of arsenic, and to develop and evaluate effects of iron injection to enhance removal of arsenic by air sparging.

5.1 CONCLUSIONS

1. Introduction of oxygen through air sparging effectively raised DO concentrations.
2. The effectiveness of increasing DO in groundwater is influenced by the heterogeneous nature of the aquifer. Specifically, the presence of fine-grained silt/clay layers in the saturated zone of the generally coarse-grained aquifer can inhibit the distribution of DO during air sparging. As a result, sparge well screen designs need to provide for distribution of air across fine-grained layers. Design options include

longer screens across fine-grained layers or multiple sparge wells as were used during pilot testing.

3. Other physical changes in the aquifer that can occur as a result of air sparging are localized changes in aquifer water levels, and changes in aquifer aqueous permeability as a result of groundwater displacement by air. Pulsing injection techniques that consist of relatively short run times and relatively longer down times compensate for these effects and result in more effective distribution of dissolved oxygen in groundwater.
4. Increasing DO concentrations in groundwater resulted in geochemically oxidizing conditions, as was evident by increased concentrations of oxidized species of arsenic and iron in groundwater and decreased concentration of reduced species for these elements.
5. There was only limited evidence of increased arsenic removal rates from groundwater under oxidizing conditions where dissolved iron was absent as an initial condition (e.g. DH-50).
6. Arsenic removal rates were significantly enhanced where iron was present in groundwater. The enhanced removal where iron was present was evident during all pilot test efforts.
7. Although arsenic concentrations were successfully reduced during sparge pilot testing, the concentrations of arsenic remained above MCLs. The data suggest that removal of arsenic may have been limited by the depletion of dissolved iron in groundwater.
8. Arsenic removal in the presence of dissolved iron probably occurs through co-precipitation and enhanced adsorption and/or entrapment with other iron compounds.

Simple stoichiometric calculations compared to measured results indicate removal of arsenic in the presence of iron did not occur by co-precipitation alone.

9. The data demonstrate that enhanced reductions of arsenic concentrations by sparging are possible where the initial concentrations of dissolved iron in groundwater are higher. Where ambient iron was present, arsenic concentrations were reduced 94% to 96%, even after iron concentrations were almost totally removed from the groundwater system by air sparging.
10. Optimal removal rates where ambient iron was present was coincident with periods where higher airflow injection rates could be achieved. A one-time reduction 99.5% was observed during optimum airflow conditions. However, optimum airflow conditions are difficult to maintain due to changes in airflow associated with changing geochemical conditions, and variable performance in airflow systems. Considerable monitoring and maintenance is required for a potential increase in arsenic removal performance.
11. Where ambient iron is not present in groundwater, air sparging was significantly less effective in reducing arsenic concentrations. Although reduction in arsenic concentrations was observed, the reduction was similar in magnitude and scope to that of up-gradient and presumably unaffected monitoring sites. This up-gradient and down-gradient trend continued after the testing program and is attributed to improving groundwater quality as a result of removal of sources of arsenic in groundwater by interim measures in previous years and suspension of plant operations.
12. Injection of iron into groundwater concurrent with air sparging resulted in significant and rapid removal of arsenic in groundwater at the injection well. Arsenic reduction at the injection well location was reduced from 30 mg/l to 0.045 mg/l or 99.9 %. However, injected iron did not migrate far from the injection point and the nearest

down-gradient monitoring well 30 feet away was the only well that showed evidence of enhanced iron in groundwater samples. Where concentrations of iron in this monitoring well were highest (13 mg/l) groundwater arsenic concentrations were reduced from 23 mg/l to 6.7 mg/l or 71%. However, elevated iron concentrations in this well could not be maintained as the iron was rapidly consumed, and typical arsenic reduction was at to 43 to 52%.

13. Stratigraphy and the presence of natural iron are significant factors in the effectiveness of air sparging in reducing arsenic concentrations. Best results were obtained where there was a presence of ambient iron in groundwater, and where sediments were more homogeneous and generally finer grained (primarily sand). Generally poorer results were obtained where ambient iron in groundwater was low, and stratigraphy was more heterogeneous with the presence of sand and gravel, and interlayered clay.
14. Injected iron was rapidly removed from groundwater near the injection point by adsorption and precipitation, and attempts to enhance iron migration to down-gradient sparging areas by increasing the frequency of iron injection generally were not successful. Water quality effects at the point of injection included elevated concentrations of dissolved iron, sulfate and TDS, and reduced concentrations of arsenic, and lower pH. Only minor water quality effects were observed in down-gradient sparge test monitoring wells, which included a minor increase in sulfate concentrations; however, the frequent injection of iron induced an increase of arsenic⁺³ concentrations while arsenic⁺⁵ concentrations decreased. This occurred in spite of elevated DO concentrations as a result of air sparge operation.
15. Dissolved arsenic and dissolved oxygen concentrations generally returned to near pre-test concentrations after sparging operations were terminated. It is not clear if return to pre-test conditions is the result of remobilization of arsenic or simply the result of up-gradient water flow from on-plant source areas into the test area. However, the

continued long-term trend of declining arsenic in up-gradient wells and down-gradient wells suggests return to pre-test conditions is dominated by the result of continued incoming flow from on-plant source areas. Contributions of arsenic from these source areas are declining as a result of implementation of interim source control measures, on-going plant cleanup actions, and suspension of plant operations.

16. The pilot testing program demonstrated that air sparging could potentially be effective in reducing off-site arsenic migration in groundwater. However, the pilot test did not achieve MCLs, nor was it successful in significantly reducing arsenic concentrations in areas where dissolved iron is not present in groundwater. However, where ambient iron was present in groundwater, arsenic concentrations were reduced over 90%.

5.2 RECOMMENDATIONS

Air sparging can be effective in reducing arsenic concentrations in groundwater where conditions allow optimum operation and the presence of ambient iron in groundwater enhances effectiveness. However, the complexity of site stratigraphy and subsurface geochemistry makes the successful operation a complex and potentially high monitoring/maintenance effort. While sparging can result in some significant reduction of arsenic concentrations where conditions are optimum, achievement of MCLs will probably not be possible under the conditions tested at East Helena.

Sparging may be more conducive to a controlled funnel and gate approach, where the media that sparging occurs can be better controlled (emplacement of a more homogeneous sand, or sand and iron mixture for example). While this approach would probably be more effective and could potentially achieve MCLs, the expense and technical difficulty associated with emplacement of groundwater diversion/curtain walls and gate system would not make this approach appropriate as an interim measure for the site.

However, sparging, as well as other technologies under consideration, including permeable reactive barriers (PRB), water control – diversion systems, traditional pump and treat options,

and other potentially applicable approaches will continue to be evaluated as part of the Corrective Measures Study (CMS) for the site and as a part of other investigation efforts. Sparging, in combination with other technologies may have applicability for long-term corrective measures at the site. Other possibilities include use of sparging at identified up-gradient source areas to change the initial oxidation state in the groundwater arsenic plume, and/or use as an air sparging in an effort to control and reduce arsenic concentrations down-gradient or off-site of the plant.

6.0 REFERENCES

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TABLES

TABLE 1-1. SUMMARY OF AIR SPARGE TESTING

Program	Date	Sampled Wells ⁽¹⁾	Comments	Iron Reagent Solution	Freshwater Flush
PHASE 1 Sparge System Well Construction	April and May 2000		Construct sparge wells: STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, SPAR-1, SPAR-2, SPAR-3.		
Pre-Sparge Water Quality Sampling	5/10/00	STW-1, STW-2, STW-3 STW-4, STW-5, STW-6,	Collect pre-sparge baseline water quality data.		
Second Round Pre-Sparge Water Quality Sampling	5/18/00	STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, DH-50	Collect pre-sparge baseline water quality data.		
Testing Sparge System	5/19/00		Evaluate sparge system air volumes and pressure readings using well SPAR-2.		
Initial Sparge System Startup (SPAR-2)	5/23/00		Start up sparge system. Set compressor to switch on and off at 15 minute intervals. Evaluate water level changes with Troll data logger at STW-5. Check dissolved oxygen at well STW-2 before startup and between sparging intervals. Problems occur with air bypassing through pressure relief valve. Air injection at well SPAR-2.		
	5/24/00		Install TROLL data logger at STW-4. Check DO at STW-2 and STW-5.		
	5/25/00		Install TROLL Data logger at STW-6.		
	5/26/00		Install TROLL Data logger at STW-3.		
Initial Sparge Test Water Quality Monitoring	5/30/00	STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, DH-50, SPAR-3	Collect baseline water quality data at recently installed well SPAR-3.		
	5/31/00		Move TROLL data logger to well DH-50		
Sparge Weekly Water Quality Monitoring	6/6/00	STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, DH-50			
Sparge Weekly Water Quality Monitoring	6/13/00	STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, DH-50			
	6/15/02		Begin air injection at both SPAR-1 and SPAR-2.		
Sparge Weekly Water Quality Monitoring	6/21/00	STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, DH-50, DH-24, EH-60			
Sparge Weekly Water Quality Monitoring	6/29/00	STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, DH-50	Reset compressor timer to run on the following hourly cycle: 15 minutes on, 45 minutes off. Well caps on STW-2 and STW-3 were loose and had been blown off by air pressure.		
Sparge Bi-Weekly Water Quality Monitoring	7/13/00	STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, DH-50			
Sparge Bi-Weekly Water Quality Monitoring	7/24/00	STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, DH-50			

TABLE 1-1. SUMMARY OF AIR SPARGE TESTING

Program	Date	Sampled Wells ⁽¹⁾	Comments	Iron Reagent Solution	Freshwater Flush
Sparge Bi-Weekly Water Quality Monitoring	8/3/00	STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, DH-50, EH-60, SPAR-3 DH-24			
Initial Startup of Sparge System at SPAR-3	8/9/00		Shut down air injection at SPAR-1 and SPAR-2 and begin air injection at SPAR-3.		
	8/10/00		Well cap at DH-24 off and full of water.		
Sparge Bi-Weekly Water Quality Monitoring	8/16/00	STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, DH-50, EH-60, SPAR-3 DH-24			
Sparge Bi-Weekly Water Quality Monitoring	8/31/00	STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, DH-50, EH-60, SPAR-3 DH-24	SPAR-3 system power supply interrupted sometime between August 16th and August 31st due to power surge. SPAR-3 system restarted on August 31, 2001		
Sparge Water Quality Monitoring	9/13/00	STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, DH-50, EH-60, SPAR-3 DH-24			
Sparge Water Quality Monitoring	9/22/00	EH-50, EH-60, DH-24 SPAR-3			
Sparge Water Quality Monitoring	10/3/00	STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, DH-50, EH-60, SPAR-3 DH-24			
Sparge Water Quality Monitoring	10/17/00	EH-50, EH-60, DH-24 SPAR-3			
Sparge Water Quality Monitoring	11/3/00	STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, DH-50, EH-60, SPAR-3 DH-24, EH-50	Sparge systems disconnected due to an electrical problem.		
	11/15/00	STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, DH-50, DH-24, SPAR-3	Samples collected as part of Post RI/FS monitoring program.		
Sparge Water Quality Monitoring	12/20/00	STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, DH-50, EH-60, SPAR-3 DH-24			
Sparge Water Quality Monitoring	2/7/01	STW-1, STW-4, STW-5 DH-50, EH-60, SPAR-3 DH-24, DH-16, DH-21, DH-19R, East Helena office sink			
PHASE II					
Start Bench Scale Testing	2/26/01	STW-1	Collect groundwater from STW-1 for iron bench scale testing. Assess feasibility to introduce soluble iron to the groundwater system in the air sparging area to enhance iron precipitation and arsenic removal during sparging.		
	5/14/01	STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, DH-50, EH-60, SPAR-3	Samples collected as part of Post RI/FS monitoring program.		

TABLE 1-1. SUMMARY OF AIR SPARGE TESTING

Program	Date	Sampled Wells ⁽¹⁾	Comments	Iron Reagent Solution	Freshwater Flush
Conduct Column Leach Tests	6/15/01	DH-24	Assess the solubility of various iron reagents in groundwater from the site. Evaluate iron attenuation by site soils. Evaluate the effect of varying iron concentrations on groundwater pH. Evaluate the effect of iron concentrations and pH on iron/arsenic removal rates. Evaluate time required for iron/arsenic precipitation. Evaluate the stability of arsenic-bearing precipitates.		
PHASE III					
Sparge Well Construction	7/17/01		Drill and complete additional sparge wells STW-7, STW-8, and STW-9 (7/17/01 - 7/19/01).		
	8/10/01	STW-7, STW-8, STW-9			
Pre-Start Up Sparge Water Quality Monitoring	9/26/01	STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, STW-7, STW-8, STW-9 DH-50, DH-24, SPAR-3			
Start up SPAR-1 and SPAR-2 Air Compressor	10/11/01		Air compressors wired properly by electrician. Air compressor turned on for SPAR-1 & 2 site. Compressor for SPAR-3 still not working. Set SPAR-1 & 2 compressor to run for 15 minutes every other hour on odd numbered hours. (i.e., 1,3,5) Air injection at wells SPAR-1 and SPAR-2.		
	10/19/01	STW-2, STW-3, STW-4 STW-5, STW-6, STW-7 STW-8, STW-9, DH-50 DH-24, SPAR-3	Water quality monitoring included only collection of field parameters and iron speciation. No laboratory samples. SPAR-3 system waiting on new compressor switch.		
	11/2/01	STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, STW-7, STW-8, STW-9 DH-50, DH-24, SPAR-3	Water quality monitoring included only collection of field parameters and iron speciation. No laboratory samples.		
Re-start SPAR-3 sparge system	11/6/01		Turned on SPAR-3 air sparge system. Set system to run for 15 minutes every other hour on even numbered hours (i.e., 2, 4)		
	11/8/01	DH-24, DH-50	Samples collected as part of Post RI/FS monitoring program.		
	11/20/01	STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, STW-7, STW-8, STW-9 DH-50, DH-24, SPAR-3			
Initial Iron Injection at SPAR-1 & 2	11/27/01			200 gallons groundwater obtained from STW-1 2500 mg/L iron solution created by mixing 77.6 grams of sodium hydrosulfite and 20.76 pounds of ferric sulfate with 200 gallons of groundwater	200 gallons groundwater obtained from STW-1 Added 77.6 grams of sodium hydrosulfite to the 200 gallons of groundwater
	11/28/01	STW-7, STW-8	Samples analyzed for dissolved iron and sulfate in the field.		
	11/30/01	STW-2, STW-3, STW-7, STW-8, STW-9			
	12/3/01	STW-7, STW-8	Collected samples for field parameters. Iron and sulfate analyzed in the field.		
	12/4/01	STW-2, STW-3, STW-7, STW-8, STW-9			
	12/7/01	STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, STW-7, STW-8, STW-9	SPAR -3 well cap not tight.		

TABLE 1-1. SUMMARY OF AIR SPARGE TESTING

Program	Date	Sampled Wells ⁽¹⁾	Comments	Iron Reagent Solution	Freshwater Flush
Second Iron Injection at SPAR-1 & 2		DH-50, DH-24, SPAR-3			
	12/12/01	STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, STW-7, STW-8, STW-9	Samples analyzed for field parameters, iron, and sulfate.		
	12/14/01	STW-2, STW-3, STW-4 STW-5, STW-6, STW-7 STW-8, STW-9, DH-50			
	12/19/01	STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, STW-7, STW-8, STW-9 DH-50, DH-24, SPAR-3			
	12/27/01	STW-2, STW-3, STW-4 STW-5, STW-6, STW-7 STW-8, DH-50			
	1/10/02	STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, STW-7, STW-8, STW-9 DH-50, DH-24, SPAR-3			
	1/16/02	STW-2, STW-3, STW-4 STW-5, STW-6, STW-7 STW-8, STW-9, DH-50			
	1/23/02	STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, STW-7, STW-8, STW-9 DH-50, DH-24, SPAR-3			
	2/5/02	STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, STW-7, STW-8, STW-9 DH-50, DH-24, SPAR-3			
	2/11/02	STW-2, STW-3, STW-7 STW-8, STW-9	Injected 3000 ppm ferrous sulfate solution into STW-7.	200 gallons groundwater obtained from STW-1 3000 mg/L iron solution created by mixing 40 grams of sodium hydrosulfite and 25 pounds of ferrous sulfate with 200 gallons of groundwater	50 gallons of groundwater obtained from STW-1
	2/12/02	STW-2, STW-3, STW-7 STW-8, STW-9	Sampled for field parameters and total iron.		
	2/13/02	STW-2, STW-3, STW-7 STW-8, STW-9, EH-100			
	2/14/02	STW-2, STW-3, STW-7 STW-8, STW-9			
	2/15/02	STW-2, STW-3, STW-7 STW-8, STW-9			
	2/19/02	STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, STW-7, STW-8, STW-9 DH-50, DH-24, SPAR-3			
	2/22/02	STW-2, STW-3, STW-5 STW-7, STW-8, STW-9			
	2/26/02	EH-100	Collected water quality samples from top and bottom of screen.		
	2/27/02	STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, STW-7, STW-8, STW-9			

TABLE 1-1. SUMMARY OF AIR SPARGE TESTING

Program	Date	Sampled Wells ⁽¹⁾	Comments	Iron Reagent Solution	Freshwater Flush
Weekly injection program initiated. Third iron injection at SPAR-1 & 2 Sparge System		DH-50			
	3/6/02	STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, STW-7, STW-8, STW-9 DH-50, DH-24, SPAR-3	Data not inadvertently not included in data base.		
	3/19/02	STW-1, STW-9, DH-24, SPAR-3	Data not inadvertently not included in data base.		
	3/26/02	STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, STW-7, STW-8, STW-9 DH-50, DH-24, SPAR-3	Data not inadvertently not included in data base.		
	4/19/02	STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, STW-7, STW-8, STW-9 DH-24, SPAR-3, DH-50			
	5/10/02	STW-4, STW-5, STW-6, STW-7, STW-8, STW-9 DH-24, SPAR-3			
	5/30/02	DH-24, DH-50	Samples collected as part of Post RI/FS monitoring program.		
	6/6/02	STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, STW-7, STW-8, STW-9 DH-24, SPAR-3			
	7/17/02	<u>Pre-Injection Sampling</u> STW-2, STW-3, STW-4 STW-7, STW-8	Sampled wells prior to iron injection at STW-7.	200 gallons groundwater obtained from STW-1 3000 mg/L iron solution created by mixing 40 grams of sodium hydrosulfite and 25 pounds of ferrous sulfate with 200 gallons of groundwater	50 gallons of groundwater obtained from STW-1
	7/19/02	<u>Post-Injection Sampling</u> STW-7, STW-8			
	7/24/02	<u>Pre-Injection Sampling</u> STW-2, STW-3, STW-4 STW-7, STW-8	Sampled wells prior to iron injection at STW-7.	200 gallons groundwater obtained from DH-51 3000 mg/L iron solution created by mixing 40 grams of sodium hydrosulfite and 25 pounds of ferrous sulfate with 200 gallons of groundwater	50 gallons of groundwater obtained from DH-51
	7/25/02	<u>Post-Injection Sampling</u> STW-7, STW-8			
	7/31/02	<u>Pre-Injection Sampling</u> STW-2, STW-3, STW-4 STW-7, STW-8	Sampled wells prior to iron injection at STW-7.	200 gallons groundwater obtained from DH-51 3000 mg/L iron solution created by mixing 40 grams of sodium hydrosulfite and 25 pounds of ferrous sulfate with 200 gallons of groundwater	50 gallons of groundwater obtained from DH-51
	8/1/02	<u>Post-Injection Sampling</u> STW-7, STW-8			
Sixth iron injection at SPAR-1 & 2 Sparge System	8/8/02	<u>Pre-Injection Sampling</u> STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, STW-7, STW-8, STW-9, DH-50 <u>Also Sampled SPAR-3 System</u> DH-24, SPAR-3	Sampled wells prior to iron injection at STW-7.	200 gallons groundwater obtained from DH-51 3000 mg/L iron solution created by mixing 40 grams of sodium hydrosulfite and 25 pounds of ferrous sulfate with 200 gallons of groundwater	50 gallons of groundwater obtained from DH-51
	8/9/02	<u>Post-Injection Sampling</u> STW-7, STW-8			
Seventh iron injection at SPAR-1 & 2 Sparge System	8/14/02	<u>Pre-Injection Sampling</u> STW-2, STW-3, STW-4 STW-7, STW-8	Sampled wells prior to iron injection at STW-7.	200 gallons groundwater obtained from DH-51 3000 mg/L iron solution created by mixing 40 grams of sodium hydrosulfite and 25 pounds of ferrous	50 gallons of groundwater obtained from DH-51

TABLE 1-1. SUMMARY OF AIR SPARGE TESTING

Program	Date	Sampled Wells ⁽¹⁾	Comments	Iron Reagent Solution	Freshwater Flush
Eighth iron injection at SPAR-1 & 2 Sparge System	8/15/02	<u>Post-Injection Sampling</u> STW-7, STW-8	EPA constructs new PRB wells. Instruments DH-24, DH-50 and STW-1. Removed expansion caps so venting to atmosphere during the period August 20 through September 30, 2002.	sulfate with 200 gallons of groundwater	50 gallons of groundwater obtained from DH-51
	8/20/02				
	8/22/02	STW-2, STW-3, STW-4 STW-7, STW-8			
	8/28/02	STW-2, STW-3, STW-4 STW-7, STW-8			
	9/5/02	<u>Pre-Injection Sampling</u> STW-2, STW-3, STW-4 STW-7, STW-8		200 gallons groundwater obtained from DH-51 3000 mg/L iron solution created by mixing 40 grams of sodium hydrosulfite and 25 pounds of ferrous sulfate with 200 gallons of groundwater	
Ninth iron injection at SPAR-1 & 2 Sparge System	9/6/02	<u>Post-Injection Sampling</u> STW-7, STW-8	Sampled wells prior to iron injection at STW-7.	200 gallons groundwater obtained from DH-51 3000 mg/L iron solution created by mixing 40 grams of sodium hydrosulfite and 25 pounds of ferrous sulfate with 200 gallons of groundwater	50 gallons of groundwater obtained from DH-51
	9/12/02	STW-7, STW-8, DH-24			
	9/19/02	<u>Pre-Injection Sampling</u> STW-2, STW-3, STW-4 STW-7, STW-8			
	9/20/02	<u>Post-Injection Sampling</u> STW-7, STW-8			
Tenth iron injection at SPAR-1 & 2 Sparge System	9/26/02	STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, STW-7, STW-8, STW-9 DH-50, DH-24, SPAR-3	Sampled wells prior to iron injection at STW-7.	200 gallons groundwater obtained from DH-51 3000 mg/L iron solution created by mixing 40 grams of sodium hydrosulfite and 25 pounds of ferrous sulfate with 200 gallons of groundwater	50 gallons of groundwater obtained from DH-51
	10/4/02	<u>Pre-Injection Sampling</u> STW-2, STW-3, STW-4 STW-7, STW-8			
	10/5/02	<u>Post-Injection Sampling</u> STW-7, STW-8			
Eleventh iron injection at SPAR-1 & 2 Sparge System	10/17/02	STW-2, STW-3, STW-4 STW-7, STW-8	Sampled wells prior to iron injection at STW-7. Frozen well cap at STW-8.	200 gallons groundwater obtained from DH-51 3000 mg/L iron solution created by mixing 40 grams of sodium hydrosulfite and 25 pounds of ferrous sulfate with 200 gallons of groundwater	50 gallons of groundwater obtained from DH-51
Twelfth iron injection at SPAR-1 & 2 Sparge System	10/23/02	STW-2, STW-3, STW-4 STW-7, STW-8	Sampled wells prior to iron injection at STW-7.	200 gallons groundwater obtained from DH-51 3000 mg/L iron solution created by mixing 40 grams of sodium hydrosulfite and 25 pounds of ferrous sulfate with 200 gallons of groundwater	50 gallons of groundwater obtained from DH-51
Thirteenth iron injection at SPAR-1 & 2 Sparge System	10/31/02	STW-2, STW-3, STW-4 STW-7, STW-8	Sampled wells prior to iron injection at STW-7.	200 gallons groundwater obtained from DH-51 3000 mg/L iron solution created by mixing 40 grams of sodium hydrosulfite and 25 pounds of ferrous sulfate with 200 gallons of groundwater	50 gallons of groundwater obtained from DH-51
	11/13/02	STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, STW-7, STW-8, STW-9 DH-50, DH-24, SPAR-3	Samples collected as part of Post RI/FS monitoring program.		

TABLE 1-1. SUMMARY OF AIR SPARGE TESTING

Program	Date	Sampled Wells ⁽¹⁾	Comments	Iron Reagent Solution	Freshwater Flush
Shutdown Sparge Systems	12/17/02	STW-7, STW-8, SPAR-3 DH-24	Turn off sparge systems		
Post Sparge Sampling	1/14/03	STW-7, STW-8, DH-24			

Notes: (1) Wells were generally sampled for field parameters (static water level, pH, specific conductance, dissolved oxygen, and temperature) common ions (sulfate, alkalinity), dissolved arsenic and iron, and arsenic speciation (As^{+3}/As^{+5}). Additional field parameters (Eh and Fe^{+2}/Fe^{+3}) and a more extensive suite of parameters for common ions and dissolved metals were analyzed for samples collected during 2000 and 2001.

**TABLE 2-1. CONSTRUCTION OF SPARGING WELLS AND MONITORING WELLS
INSTALLED DURING INTERIM MEASURES SPARGING PILOT TEST**

Well Name	Date Installed	Phase	Casing Size (inches)	Ground Surface Elevation (feet)	Measuring Point (MP) Elevation (feet)	Static Water Level (feet below MP)	Static Water Elevation (feet)	Total Depth (feet)	Screen Interval (ft bgs)
Sparging Wells									
SPAR-1	4/27/00	I	2	3898.72	3901.14	33	3868.14	40	38-40
SPAR-2	4/28/00	I	2	3898.44	3901.62	33	3868.62	41	36-39
SPAR-3	5/22/00	I	2	3898.04	3900.59	32.86	3867.73	40	35-37
Monitoring Wells									
STW-1	4/26/00	I	2	3899.77	3902.21	32.24	3869.97	40	33-38
STW-2	4/25/00	I	2	3898.30	3900.89	31.47	3869.42	40	34-39
STW-3	4/29/00	I	2	3898.73	3901.39	31.87	3869.52	40	34.5-39.5
STW-4	5/2/00	I	2	3898.09	3900.59	31.18	3869.41	40	32-37
STW-5	5/1/00	I	2	3897.74	3900.45	31.06	3869.39	40	34-39
STW-6	4/30/00	I	2	3898.11	3900.76	31.31	3869.45	40	34-39
STW-7	7/17/01	III	2	3899.828	3902.118	32.43	3869.69	40	25-40
STW-8	7/18/01	III	2	3899.534	3902.034	32.42	3869.61	40	35-40
STW-9	7/19/01	III	2	3898.399	3900.65	31.23	3869.42	40	35-40

TABLE 2-2. SPARGING TEST GROUNDWATER SAMPLE COLLECTION AND ANALYSIS

Sample Location ⁽¹⁾	Purpose	Sample Dates	Analytical Suite ^(2,3)
PHASE 1			
STW-1, STW-2, STW-3 STW-4, STW-5, STW-6 DH-50 (E)	Phase I Pretest Monitoring Characterize groundwater chemistry prior to air sparging	04/25/2000-05/10/2000	F,C,M, A
STW-1, STW-2, STW-3 STW-4, STW-5, STW-6 DH-50 (E)	Second Round Pretest Monitoring Characterize groundwater chemistry prior to air sparging	5/18/00	F,M
STW-1, STW-2, STW-3 STW-4, STW-5, STW-6 DH-50 (E)	First Round Sparge Test Monitoring Characterize groundwater chemistry during Phase I air sparging test	5/30/00	F,M
STW-1, STW-2, STW-3 STW-4, STW-5, STW-6 DH-50 (E)	Second Round Sparge Test Monitoring Characterize groundwater chemistry during Phase I air sparging test	6/6/00	F,M,A
STW-1, STW-2, STW-3 STW-4, STW-5, STW-6 DH-50 (E)	Third Round Sparge Test Monitoring Characterize groundwater chemistry during Phase I air sparging test	6/13/00	F,M
STW-1, STW-2, STW-3 STW-4, STW-5, STW-6 DH-50 (E), DH-24 (E), DH-51 (E) EH-60 (E)	Fourth Round Sparge Test Monitoring Characterize groundwater chemistry during Phase I air sparging test	6/21/00	F,C,M, A
STW-1, STW-2, STW-3 STW-4, STW-5, STW-6 DH-50 (E)	Fifth Through Eighth Round Sparge Test Monitoring Characterize groundwater chemistry during Phase I air sparging test	6/29/00 7/13/00 7/24/00	F,C,M,A
STW-1, STW-2, STW-3 STW-4, STW-5, STW-6 DH-50 (E), DH-24 (E), EH-60 (E) SPAR-3	Final Rounds Sparge Test Monitoring Characterize groundwater chemistry during Phase I air sparging test	8/3/00 8/16/00	F,A, As(diss)
STW-1, STW-2, STW-3 STW-4, STW-5, STW-6 DH-50 (E), DH-24 (E), EH-60 (E) SPAR-3	First Four Rounds Sparge Test Monitoring Characterize groundwater chemistry during second Phase I air sparging test	8/16/00 8/31/00 9/13/00	F,A, As(diss)
SPAR-3, DH-24 (E), EH-60 (E) EH-50 (E)	Fifth Round Sparge Test Monitoring Characterize groundwater chemistry during second Phase I air sparging test	10/17/00	F,A, As(diss)
STW-1, STW-4, DH-50 (E) DH-24 (E), SPAR-3, EH-60 (E) EH-50 (E)	Sixth Round Sparge Test Monitoring Characterize groundwater chemistry during second Phase I air sparging test	11/3/00	F,A, As(diss)
PHASE 3 STW-1, STW-2, STW-3 STW-4, STW-5, STW-6 DH-50 (E), DH-24 (E), EH-60 (E) SPAR-3	Seventh Round Sparge Test Monitoring Characterize groundwater chemistry during second Phase I air sparging test	12/20/00	F,C,M,A

TABLE 2-2. SPARGING TEST GROUNDWATER SAMPLE COLLECTION AND ANALYSIS

Sample Location ⁽¹⁾	Purpose	Sample Dates	Analytical Suite ^(2,3)
STW-1, STW-4, STW-5 DH-50, EH-60, SPAR-3 DH-24, DH-16, DH-21, DH-19R, East Helena office sink	Eighth Round Sparge Test Monitoring Characterize groundwater chemistry during second Phase I air sparging test	2/7/01	F, A, As(diss), Fe (diss)
STW-7, STW-8, STW-9	Baseline monitoring of SPAR-1 & 2 sparge system wells	8/10/01	F, C, M, A
STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, STW-7, STW-8, STW-9 DH-50, DH-24, SPAR-3	Pre-Start Up Sparge Water Quality Monitoring.	9/26/01	F, C, M, A
STW-2, STW-3, STW-4 STW-5, STW-6, STW-7 STW-8, STW-9, DH-50 DH-24, SPAR-3	First Round Sparge Test Monitoring Characterize groundwater chemistry during Phase III air sparging test	10/19/01	F, Fe Spec
STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, STW-7, STW-8, STW-9 DH-50, DH-24, SPAR-3	Second Round Sparge Test Monitoring Characterize groundwater chemistry during Phase III air sparging test	11/2/01	F, Fe Spec
STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, STW-7, STW-8, STW-9 DH-50, DH-24, SPAR-3	Third Round Sparge Test Monitoring Characterize groundwater chemistry during Phase III air sparging test	11/20/01	F, C, M, A
STW-7, STW-8	Post injection sampling after initial iron injection at SPAR-1 & 2 Characterize groundwater chemistry during iron injection at SPAR-1 & 2	11/28/01	Fe, SO ₄
STW-2, STW-3, STW-7, STW-8, STW-9	Characterize groundwater chemistry after initial iron injection at SPAR-1 & 2	11/30/01	F, As (diss), Fe spec
STW-7, STW-8	Characterize groundwater chemistry after initial iron injection at SPAR-1 & 2	12/3/01	F, Fe, SO ₄
STW-2, STW-3, STW-7, STW-8, STW-9	Characterize groundwater chemistry after initial iron injection at SPAR-1 & 2	12/4/01	F, C, As (diss), Fe spec
STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, STW-7, STW-8, STW-9 DH-50, DH-24, SPAR-3	Characterize groundwater chemistry after initial iron injection at SPAR-1 & 2	12/7/01	F, C, M, A
STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, STW-7, STW-8, STW-9	Characterize groundwater chemistry after initial iron injection at SPAR-1 & 2	12/12/01	F, Fe, SO ₄

TABLE 2-2. SPARGING TEST GROUNDWATER SAMPLE COLLECTION AND ANALYSIS

Sample Location ⁽¹⁾	Purpose	Sample Dates	Analytical Suite ^{2,3,4}
STW-2, STW-3, STW-4 STW-5, STW-6, STW-7 STW-8, STW-9, DH-50	Characterize groundwater chemistry after initial iron injection at SPAR-1 & 2	12/14/01	F,C, As (diss), Fe spec
STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, STW-7, STW-8, STW-9 DH-50, DH-24, SPAR-3	Characterize groundwater chemistry after initial iron injection at SPAR-1 & 2	12/19/01	F,CM,A
STW-2, STW-3, STW-4 STW-5, STW-6, STW-7 STW-8, DH-50	Characterize groundwater chemistry after initial iron injection at SPAR-1 & 2	12/27/01	F,C,As (diss), Fe (diss)
STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, STW-7, STW-8, STW-9 DH-50, DH-24, SPAR-3	Characterize groundwater chemistry after initial iron injection at SPAR-1 & 2	1/10/02	F,CM,A
STW-2, STW-3, STW-4 STW-5, STW-6, STW-7 STW-8, STW-9, DH-50	Characterize groundwater chemistry after initial iron injection at SPAR-1 & 2	1/16/02	F,C,As (diss), Fe (diss)
STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, STW-7, STW-8, STW-9 DH-50, DH-24, SPAR-3	Characterize groundwater chemistry after initial iron injection at SPAR-1 & 2	1/23/02	F,CM,A
STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, STW-7, STW-8, STW-9 DH-50, DH-24, SPAR-3	Characterize groundwater chemistry after initial iron injection at SPAR-1 & 2	2/5/02	F,CM,A
STW-2, STW-3, STW-7 STW-8, STW-9	Characterize groundwater chemistry prior to second iron injection at SPAR-1 & 2	2/11/02	F,C,As (diss), Fe (diss)
STW-2, STW-3, STW-7 STW-8, STW-9	Characterize groundwater chemistry prior to second iron injection at SPAR-1 & 2	2/12/02	F,C,As (diss), Fe (diss)
STW-2, STW-3, STW-7 STW-8, STW-9, EH-100	Characterize groundwater chemistry prior to second iron injection at SPAR-1 & 2	2/13/02	F,C,As (diss), Fe (diss)
STW-2, STW-3, STW-7 STW-8, STW-9	Characterize groundwater chemistry prior to second iron injection at SPAR-1 & 2	2/14/02	F,C,As (diss), Fe (diss)
STW-2, STW-3, STW-7 STW-8, STW-9	Characterize groundwater chemistry prior to second iron injection at SPAR-1 & 2	2/15/02	F,C,As (diss), Fe (diss)
STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, STW-7, STW-8, STW-9 DH-50, DH-24, SPAR-3	Characterize groundwater chemistry prior to second iron injection at SPAR-1 & 2	2/19/02	F,CM,A
STW-2, STW-3, STW-5 STW-7, STW-8, STW-9	Characterize groundwater chemistry prior to second iron injection at SPAR-1 & 2	2/22/02	F,C,As (diss), Fe (diss)
STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, STW-7, STW-8, STW-9 DH-50	Characterize groundwater chemistry prior to second iron injection at SPAR-1 & 2	2/27/02	F,C,As (diss), Fe (diss)

TABLE 2-2. SPARGING TEST GROUNDWATER SAMPLE COLLECTION AND ANALYSIS

Sample Location ⁽¹⁾	Purpose	Sample Dates	Analytical Suite ^(2,3)
STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, STW-7, STW-8, STW-9 DH-50, DH-24, SPAR-3	Characterize groundwater chemistry prior to second iron injection at SPAR-1 & 2	3/6/02	F,C,As (diss), Fe (diss)
STW-1,STW-9, DH-24, SPAR-3	Characterize groundwater chemistry prior to second iron injection at SPAR-1 & 2	3/19/02	F,C,As (diss), Fe (diss)
STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, STW-7, STW-8, STW-9 DH-50, DH-24, SPAR-3	Characterize groundwater chemistry prior to second iron injection at SPAR-1 & 2	3/26/02	F,C,As (diss), Fe (diss)
STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, STW-7, STW-8, STW-9 DH-24, SPAR-3, DH-50	Characterize groundwater chemistry prior to second iron injection at SPAR-1 & 2	4/19/02	F,C,M,A
STW-4, STW-5, STW-6, STW-7, STW-8, STW-9 DH-24, SPAR-3	Characterize groundwater chemistry prior to second iron injection at SPAR-1 & 2	5/10/02	F,C,M,A
STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, STW-7, STW-8, STW-9 DH-24, SPAR-3	Characterize groundwater chemistry prior to second iron injection at SPAR-1 & 2	6/6/02	F,C,M,A
STW-2, STW-3, STW-4 STW-7, STW-8	Characterize groundwater chemistry prior to third iron injection at SPAR-1 & 2	7/17/02	F,C,As (diss), Fe (diss)
STW-7, STW-8	Characterize groundwater chemistry after third iron injection at SPAR-1 & 2	7/19/02	F,C,As (diss), Fe (diss)
STW-2, STW-3, STW-4 STW-7, STW-8	Characterize groundwater chemistry prior to fourth iron injection at SPAR-1 & 2	7/24/02	F,C,M,A
STW-7, STW-8	Characterize groundwater chemistry after fourth iron injection at SPAR-1 & 2	7/25/02	F,C,M,A
STW-2, STW-3, STW-4 STW-7, STW-8	Characterize groundwater chemistry prior to fifth iron injection at SPAR-1 & 2	7/31/02	F,C,A,As(diss), Fe (Diss)
STW-7, STW-8	Characterize groundwater chemistry after fifth iron injection at SPAR-1 & 2	8/1/02	F,C,A,As(diss), Fe (Diss)
STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, STW-7, STW-8, STW-9, DH-50 DH-24, SPAR-3	Characterize groundwater chemistry prior to sixth iron injection at SPAR-1 & 2	8/8/02	F,C,A,As(diss), Fe (Diss)
STW-7, STW-8	Characterize groundwater chemistry after sixth iron injection at SPAR-1 & 2	8/9/02	F,C,A,As(diss), Fe (Diss)
STW-2, STW-3, STW-4 STW-7, STW-8	Characterize groundwater chemistry prior to seventh iron injection at SPAR-1 & 2	8/14/02	F,C,A,As(diss), Fe (Diss)

TABLE 2-2. SPARGING TEST GROUNDWATER SAMPLE COLLECTION AND ANALYSIS

Sample Location ⁽¹⁾	Purpose	Sample Dates	Analytical Suite ^(2,3,4)
STW-7, STW-8	Characterize groundwater chemistry after seventh iron injection at SPAR-1 & 2	8/15/02	F,C,A,As(diss), Fe (Diss)
STW-2, STW-3, STW-4 STW-7, STW-8	Characterize groundwater chemistry after seventh iron injection at SPAR-1 & 2	8/22/02	F,C,A,As(diss), Fe (Diss)
STW-2, STW-3, STW-4 STW-7, STW-8	Characterize groundwater chemistry after seventh iron injection at SPAR-1 & 2	8/28/02	F,C,A,As(diss), Fe (Diss)
STW-2, STW-3, STW-4 STW-7, STW-8	Characterize groundwater chemistry prior to eighth iron injection at SPAR-1 & 2	9/5/02	F,C,A,As(diss), Fe (Diss)
STW-7, STW-8	Characterize groundwater chemistry after eighth iron injection at SPAR-1 & 2	9/6/02	F,C,A,As(diss), Fe (Diss)
STW-7, STW-8, DH-24	Characterize groundwater chemistry after eighth iron injection at SPAR-1 & 2	9/12/02	F,C,A,As(diss), Fe (Diss)
STW-2, STW-3, STW-4 STW-7, STW-8	Characterize groundwater chemistry prior to ninth iron injection at SPAR-1 & 2	9/19/02	F,C,A,As(diss), Fe (Diss)
STW-7, STW-8	Characterize groundwater chemistry after ninth iron injection at SPAR-1 & 2	9/20/02	F,C,A,As(diss), Fe (Diss)
STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, STW-7, STW-8, STW-9 DH-50, DH-24, SPAR-3	Characterize groundwater chemistry after ninth iron injection at SPAR-1 & 2	9/26/02	F,C,A,As(diss), Fe (Diss)
STW-2, STW-3, STW-4 STW-7, STW-8	Characterize groundwater chemistry prior to tenth iron injection at SPAR-1 & 2	10/4/02	F,C,A,As(diss), Fe (Diss)
STW-7, STW-8	Characterize groundwater chemistry after tenth iron injection at SPAR-1 & 2	10/5/02	F,C,A,As(diss), Fe (Diss)
STW-2, STW-3, STW-4 STW-7, STW-8	Characterize groundwater chemistry prior to eleventh iron injection at SPAR-1 & 2	10/17/02	F,C,A,As(diss), Fe (Diss)
STW-2, STW-3, STW-4 STW-7, STW-8	Characterize groundwater chemistry prior to twelfth iron injection at SPAR-1 & 2	10/23/02	F,C,A,As(diss), Fe (Diss)
STW-2, STW-3, STW-4 STW-7, STW-8	Characterize groundwater chemistry prior to thirteenth iron injection at SPAR-1 & 2	10/31/02	F,C,A,As(diss), Fe (Diss)
STW-1, STW-2, STW-3 STW-4, STW-5, STW-6, STW-7, STW-8, STW-9 DH-50, DH-24, SPAR-3	Characterize groundwater chemistry as part of Post RI/FS Monitoring Program	11/13/02	F,C,M,A
STW-7, STW-8, SPAR-3 DH-24	Characterize groundwater chemistry prior to sparge system shutdown	12/17/02	F,C,A,As(diss), Fe (Diss)

TABLE 2-2. SPARGING TEST GROUNDWATER SAMPLE COLLECTION AND ANALYSIS

Sample Location ⁽¹⁾	Purpose	Sample Dates	Analytical Suite ^(2,3,4)
STW-7, STW-8, DH-24	Characterize groundwater chemistry after sparge system shutdown	1/14/03	F, C, A, As(diss), Fe (Diss)

(1) (E) = Existing wells

(2) F = field parameters C = common ions M = metals A = arsenic speciation, As(diss) = dissolved arsenic Fe (diss) = dissolved iron, Fe spec = iron speciation SO4 = sulfate

(3) Samples were analyzed for dissolved constituents (field-filtered through a 0.45 µm filter).

(4) Methods from EPA's *Test Methods for Evaluating Solid Waste, SW-846* (1992) or *Methods for Chemical Analysis of Water and Wastes* (1983).

For trace constituents and major cations, Method 6010 is ICP, Method 6020 is ICP-MS, and other methods are flame or graphite furnace AA.

TABLE 2-3. PARAMETER LIST

Analytical Parameters	Laboratory Methods ⁽⁴⁾	Project Detection Limit Goal (mg/L)
Field Parameters (F)		
pH	N/A	N/A
specific conductance		
dissolved oxygen		
temperature		
Eh		
Fe+2/Fe+3		
SWL (static water level)		
Laboratory Parameters Common Constituents (C)		
pH	150.1	
SC	120.1	
Ca	6010A/7140	5
Mg	6010A/7450	5
Na	6010A/7770	5
K	6010A/7610	5
HCO ₃	310.1	1
CO3	310.1	1
SO ₄	9036	1
Cl	325.2	1
Trace Constituents ⁽³⁾ (M)		
As (diss)	7060/6010A/6020	0.005
Cd (diss)	7131/7130/6010A/6020	0.001
Fe (diss)	6010A	0.02
Mn (diss)	6010A	0.015
Pb (diss)	7421/7420/6010A/6020	0.005
Zn (diss)	7950/6010A/6020	0.02
Arsenic Speciation (A)		
As3+	7060/6010A/6020	0.005
As5+	7060/6010A/6020	0.005

(1) (E) = Existing wells

(2) F = field parameters C= common ions M = metals A= arsenic speciation

(3) Samples were analyzed for dissolved constituents (field-filtered through a 0.45 µm filter).

(4) Methods from EPA's *Test Methods for Evaluating Solid Waste, SW-846* (1992) or *Methods for Chemical Analysis of Water and Wastes* (1983).

For trace constituents and major cations, Method 6010 is ICP, Method 6020 is ICP-MS, and other methods are flame or graphite furnace AA.

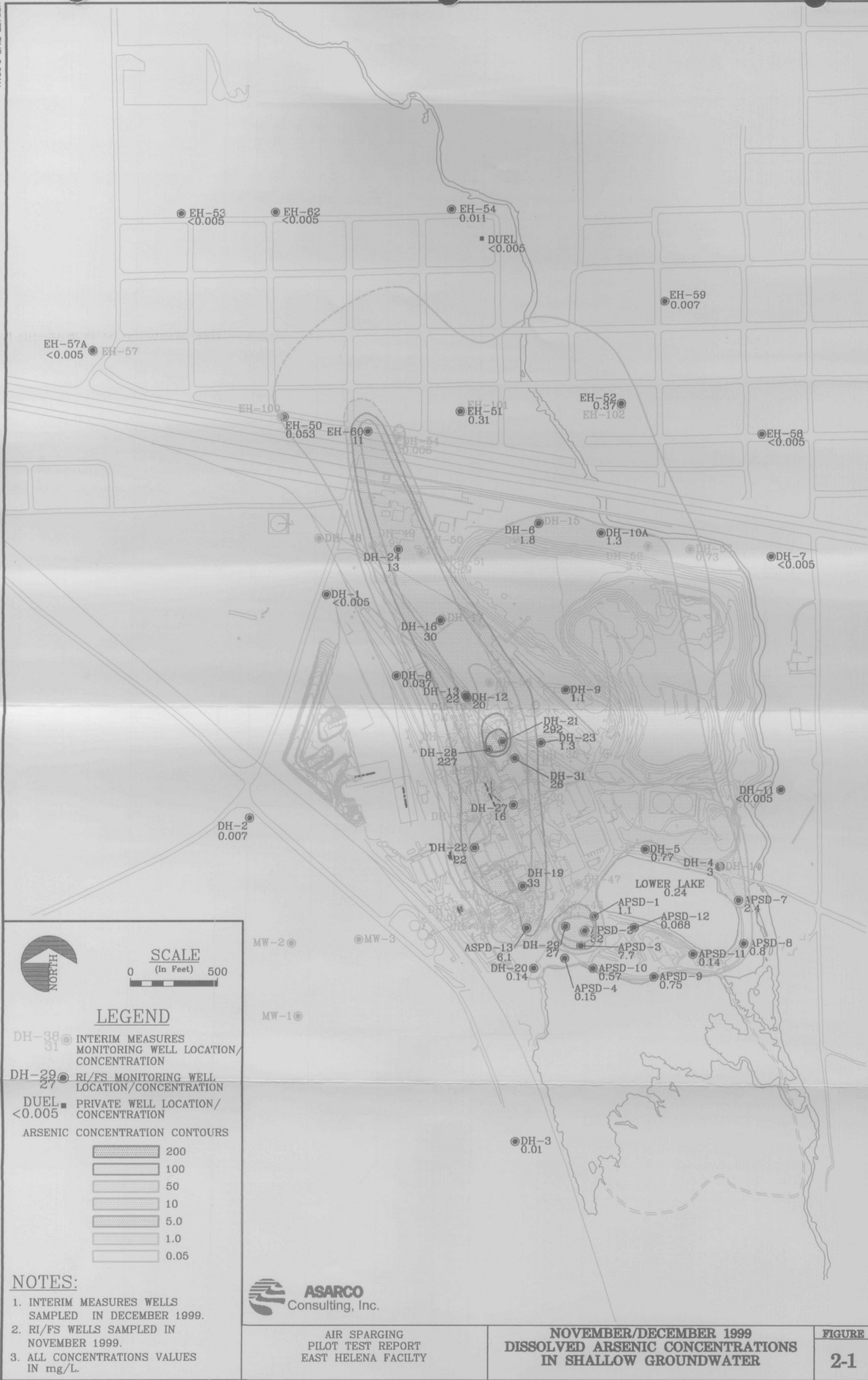
(5) Field duplicates and blanks were collected at a minimum frequency of 1 per 20 field samples.

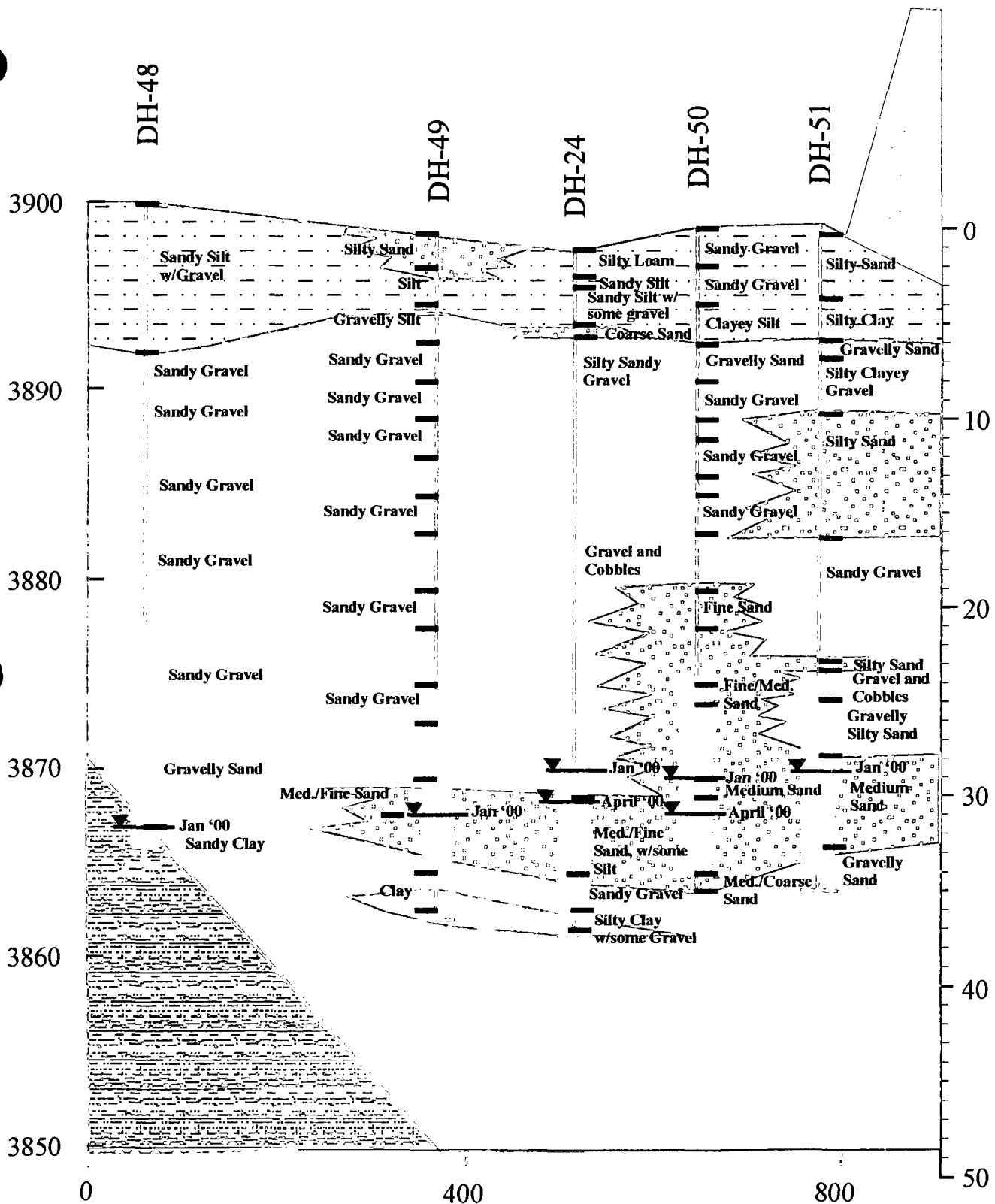
TABLE 2-4 BASELINE WATER QUALITY RESULTS

Site Code	Sample Date	Water Depth	Eh	Oxygen (FLD)	pH	pH (LAB)	SC (LAB)	SC (FLD)	Temp.	Ca	Mg	Na	K	HCO3	CO3	SO4	Cl	As	As+3	As+5	Cd	Fe	Fe (FLD)	Fe+2 (FLD)	Pb	Mn	Zn	
Units		feet	milliVolts	mg/L	s.u.	s.u.	umhos/cm at 25 C		Celcius	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L		
Phase I SPAR-1 & SPAR-2 Spurge System																												
DH-50	5/18/00	33.68	331	0.97	6.77			2540	13.9									12				<0.0005	<0.025	0.01	0.01	<0.0025	2.2	0.54
STW-1	5/10/00	33.77	241	1.29	6.88	7.8	2890	2790	12.7	68	16	521	13	256	0.5	921	229	46	46	3.8	<0.0005	0.13	0.2	<0.05	<0.0025	2.5	0.16	
	5/18/00	33.75	224	1.18	6.99			2940	13.6									48			0.001	0.17	0.2	0.17	<0.0025	2.5	0.22	
STW-2	5/10/00	33.04	274	1.07	6.84	7.8	2620	2650	12.4	78	19	464	13	268	0.5	856	178	24	14	11	<0.0005	<0.025	0.1	0.2	<0.0025	2.7	0.16	
	5/18/00	33	287	1.05	6.96			2640	13.5									27			<0.0005	<0.025	0.03	0.01	<0.0025	2.7	0.23	
STW-3	5/10/00	33.47	319	1.42	6.82	8	2550	2680	11.9	73	18	452	13	259	0.5	842	188	22	12	13	<0.0005	<0.025	0.1	<0.05	<0.0025	2.9	0.12	
	5/18/00	33.42	274	1.02	6.95			2580	13.7									25			<0.0005	0.05	0.09	0.07	<0.0025	3.3	0.2	
STW-4	5/10/00	32.78	216	1.28	6.76	7.5	2650	2670	12.3	70	18	458	13	251	0.5	844	182	37	37	3.1	<0.0005	0.49	0.5	0.7	<0.0025	3.2	0.25	
	5/18/00	32.75	204	1	6.96			2670	13.7									40			<0.0005	0.56	0.62	0.61	<0.0025	3.4	0.34	
STW-5	5/10/00	32.7	316	1.38	6.69	7.8	2590	2720	12.1	92	23	417	12	271	0.5	875	187	17	8.7	9.8	<0.0005	<0.025	0.1	<0.05	<0.0025	2.7	0.2	
	5/18/00	32.64	309	1.15	6.83			2620	13.5									19			0.002	<0.025	0.05	0.03	<0.0025	2.8	0.26	
STW-6	5/10/00	32.91	301	1.45	6.91	7.8	2560	2700	12.2	66	15	453	12	239	0.5	806	182	27	15	14	<0.0005	0.094	0.2	0.1	<0.0025	2.6	0.1	
	5/18/00	32.87	282	0.96	7.05			2560	13.8									28			<0.0005	<0.025	0.07	0.05	<0.0025	2.7	0.16	
SP-1	Not Sampled																											
SP-2	Not Sampled																											
Phase I SPAR-3 Spurge System																												
DH-24	5/1/00		459	3.62	6.01	6	1116	1147	11.9	49	21	113	13	62	<1.0	435	44	19	17	3.5	0.13	12			<0.005	7.4	4.7	
	8/3/00	27.74	247	0.93	6.17	6	1066	1120	13.9	46	18	109	12		<0.5		30	20	14	5.9	0.12	11		10.4	<0.0025	6.7	4.3	
	8/16/00	27.83	277	0.93	6.4			1031	13.4									16	13	2.3			8	8.2				
EH-60	5/3/00	22.82	384	3.8	6.7	6.9	1946	2020	12.3	85	25	268	12	262	<1.0	669	132	11	8.6	3.6	0.001	0.23			<0.005	21	0.034	
	8/3/00	20.86	287	1.08	6.28	7.3	1902	2050	12.5	81	23	264	11	256	<0.5	810	110	11	8.2	4.5	<0.0005	0.18		0.16	<0.0025	19	0.023	
	8/16/00	20.99	288	0.73	6.1			1432	12.6									11	7.9	4.2			0.17	0.16				
SP-3	8/3/00	31.79	255	0.94	6.17	6	1080	1116	13.8	49	19	113	13	49	<0.5	579	36	25	21	0.94	0.12	12		11.8	<0.0025	7	4.4	
	8/16/00	33.18	275	1.33	6.9			1098	13.6									19	17	1.4			4.6	4.2				

Note: Phase I SPAR-1 test began 5/23/2000 and Phase I SPAR-3 test began 8/19/2000

FIGURES





**AIR SPARGING
PILOT TEST REPORT
EAST HELENA FACILITY**

**GEOLOGIC CROSS SECTION
IN AREA OF
AIR SPARGING**

FIGURE

2-2



SCALE
(In Feet) 0 60

LEGEND

SPAR-1 ● PROPOSED AIR SPARGING WELL LOCATION

DH-49 ● INTERIM MEASURES MONITORING WELL LOCATION

DH-24 ● EXISTING MONITORING WELL

13 ARSENIC CONCENTRATION

3869.9 GROUNDWATER ELEVATION IN FEET ABOVE MEAN SEA LEVEL

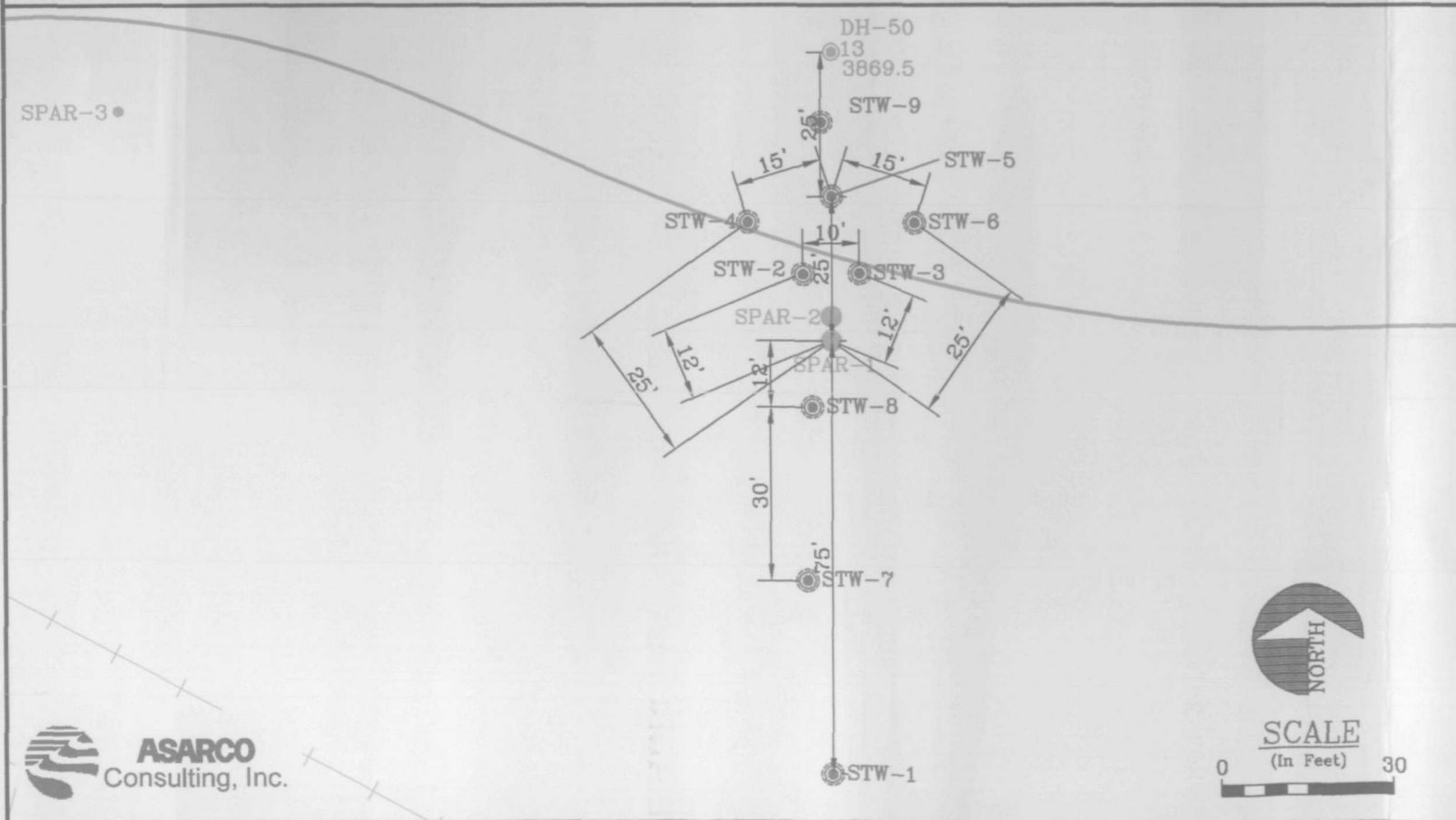
STW-4 ● PROPOSED MONITORING WELL LOCATION

GROUNDWATER POTENTIOMETRIC CONTOUR FOR THE SHALLOW AQUIFER SYSTEM (JAN 2000)

ARSENIC CONCENTRATION CONTOURS (mg/L)



DETAIL VIEW

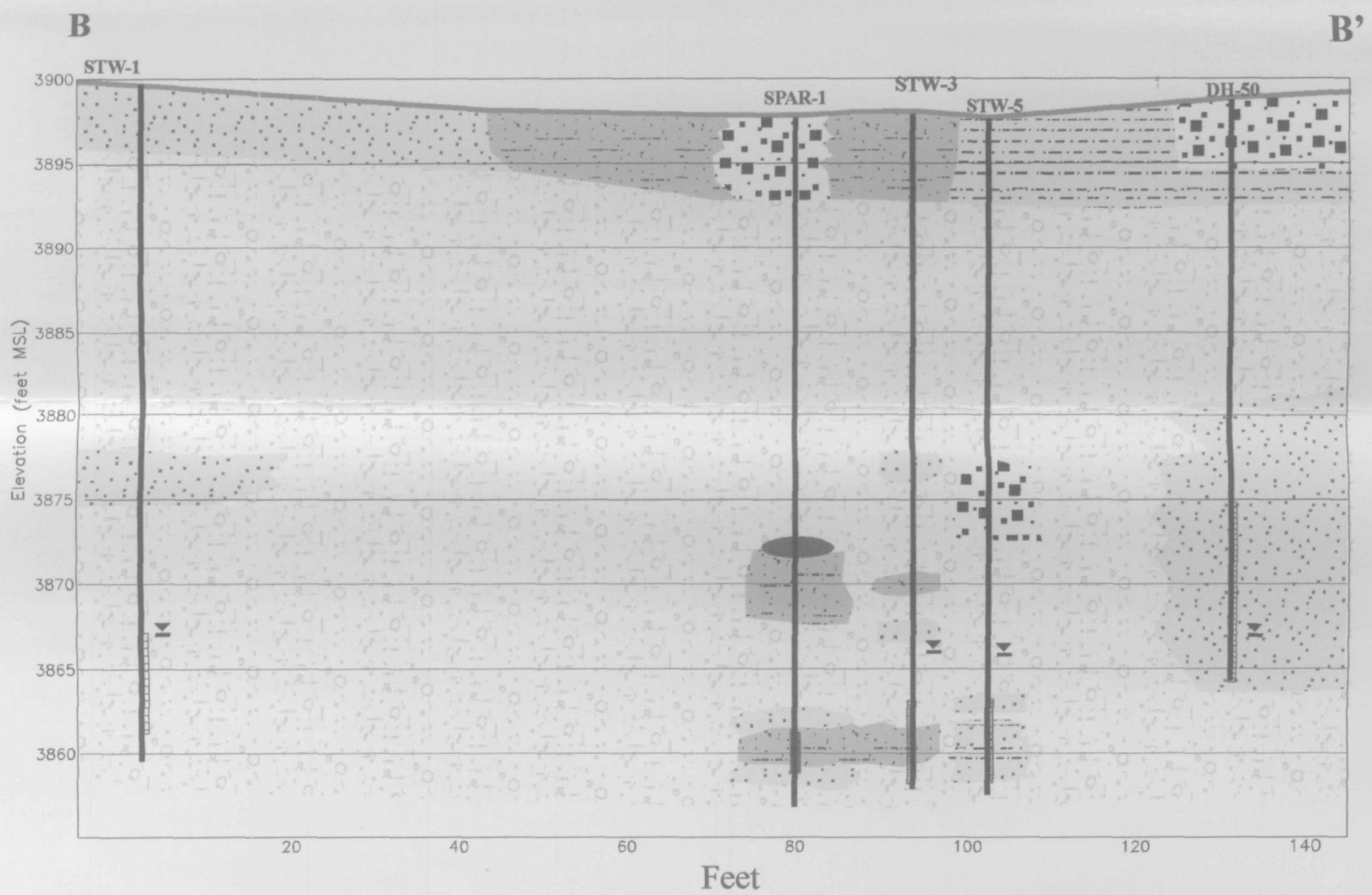
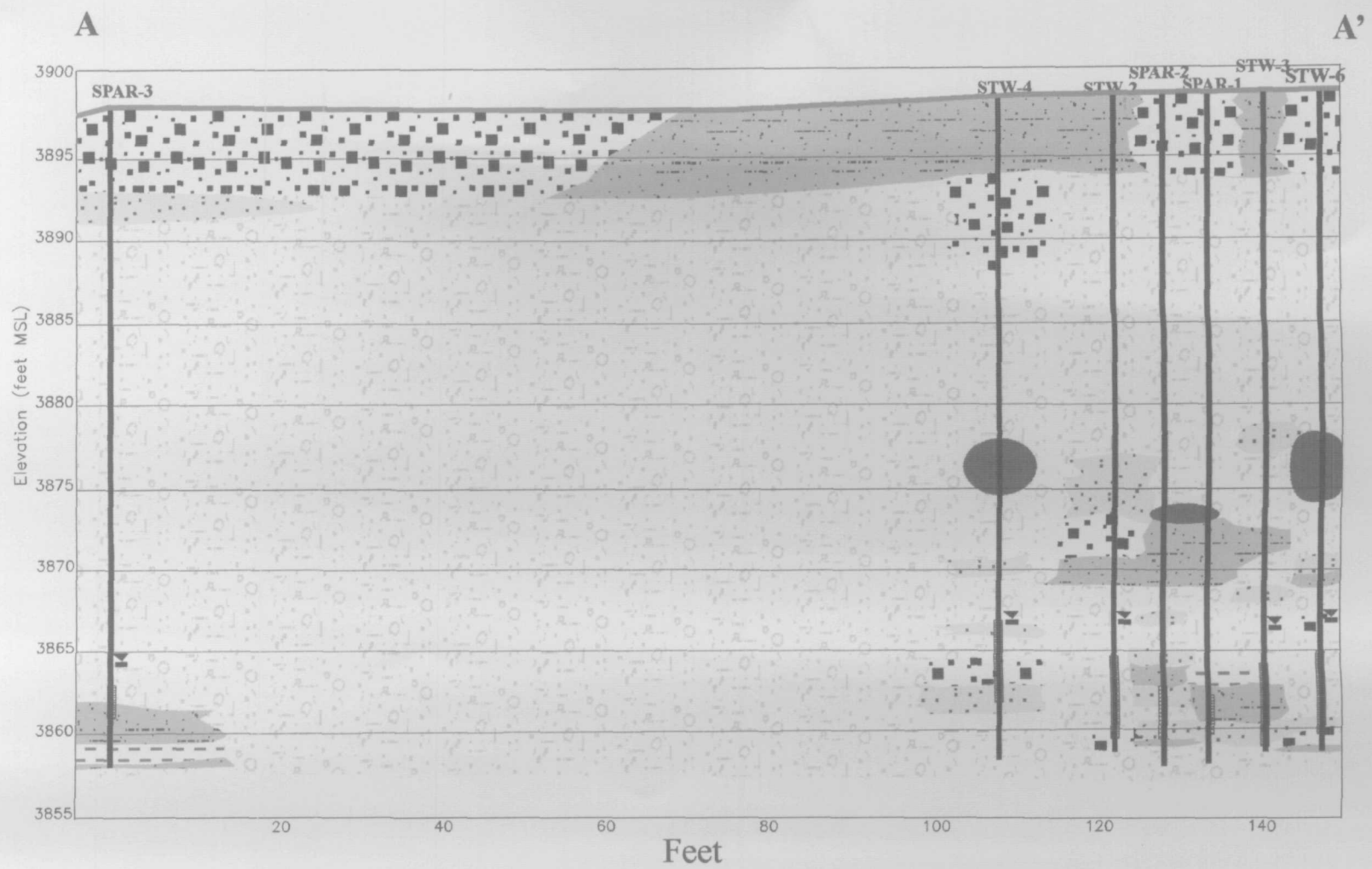


AIR SPARGING
PILOT TEST REPORT
EAST HELENA FACILITY

LOCATION OF SPARGE WELLS AND
MONITORING WELLS FOR
THE AIR SPARGING PILOT
TEST PROGRAM

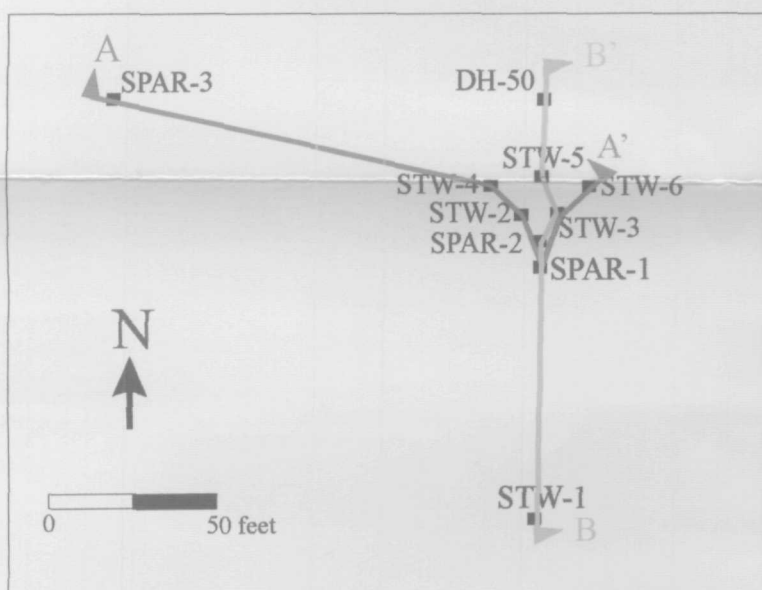
FIGURE

2-3



Legend

- Silty Clay/Clay
- Silty Sand, Gravel, and Cobbles
- Sand and Gravel/Gravelly Sand
- Silty Sand
- Sand
- Silt
- Boulder



**AIR SPARGING
PILOT TEST REPORT
EAST HELENA FACILITY**

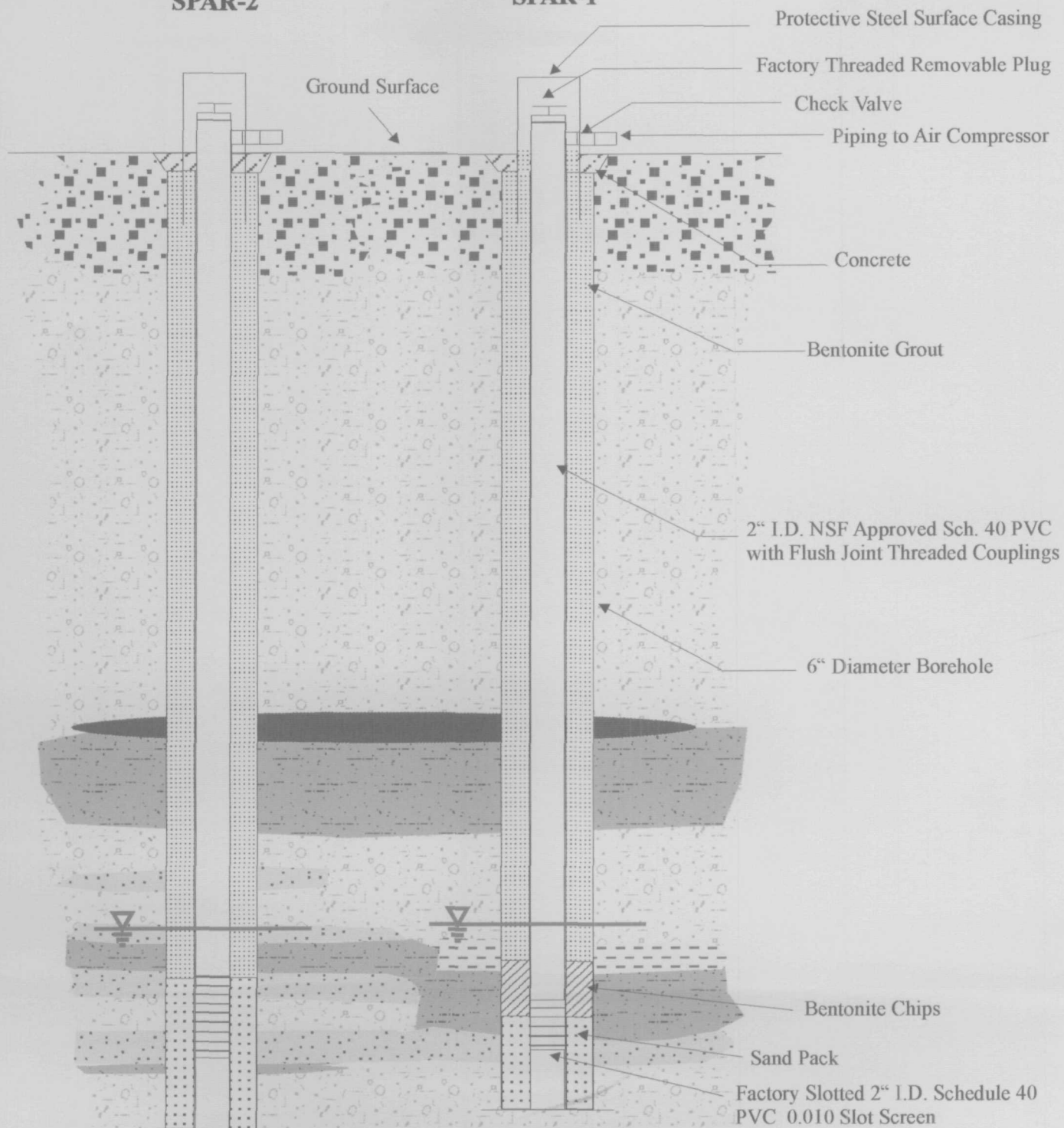
**GEOLOGIC CROSS SECTIONS
AT SPARGE WELLS**

FIGURE

2-4

SPAR-2

SPAR-1



Legend

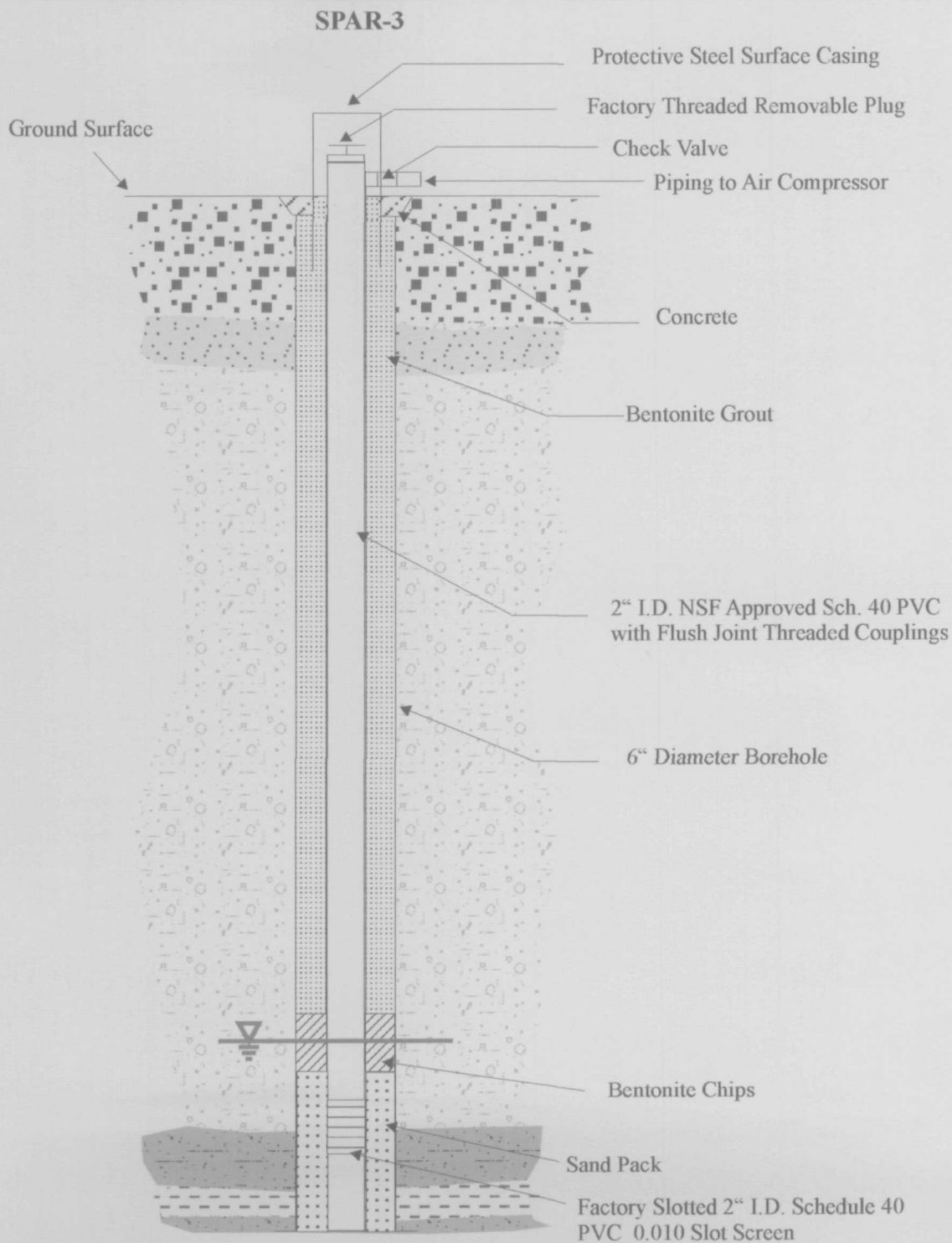
	Silty Sand, Gravel, and Cobbles		Silty Clay/Clay		Silt
	Sand and Gravel/Gravelly Sand		Silty Sand		Sand
					Boulder

AIR SPARGING
PILOT TEST REPORT
EAST HELENA FACILITY

WELL CONSTRUCTION
AND STRATIGRAPHY FOR
SPAR-1 AND SPAR-2

FIGURE

2-5



Legend

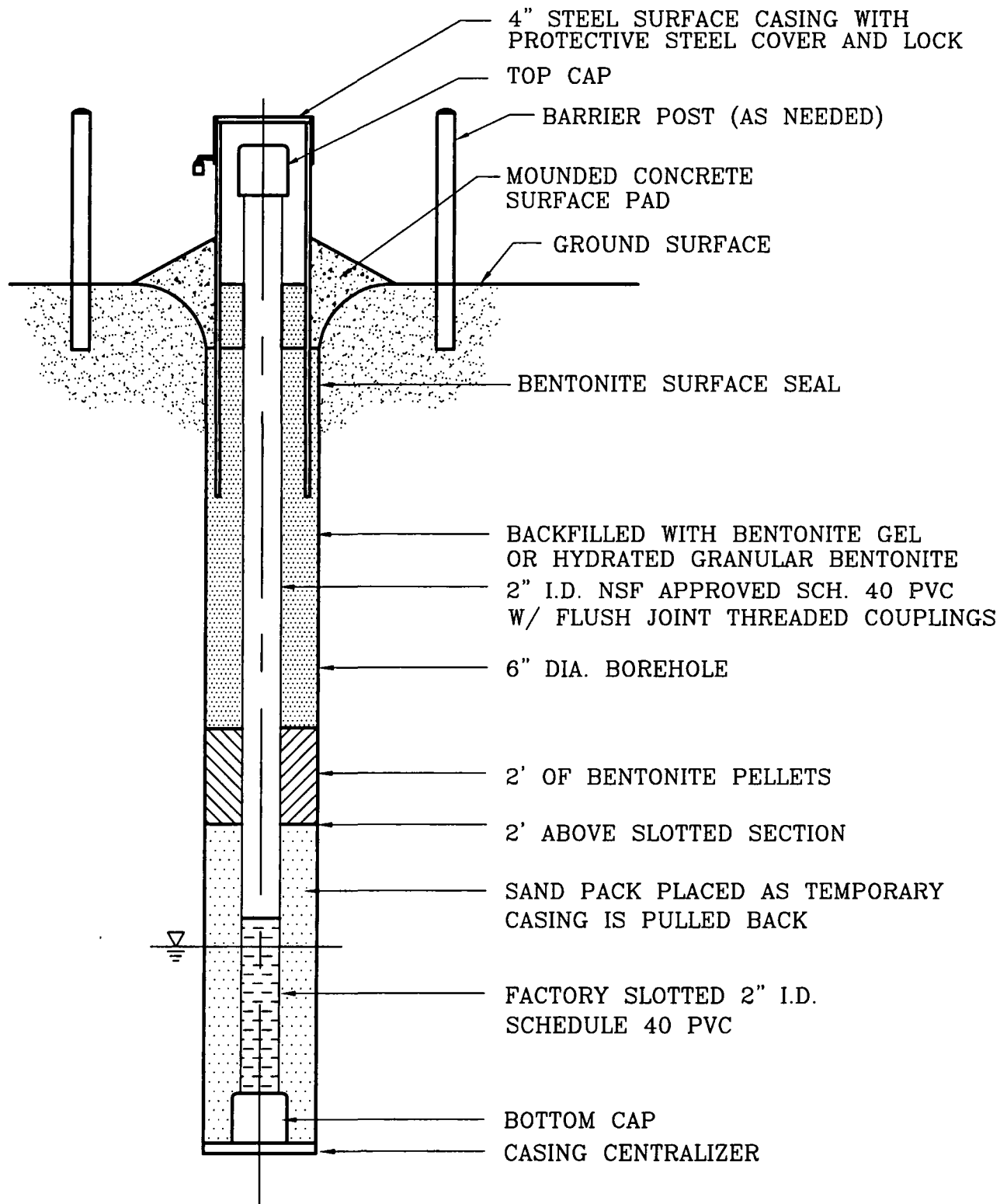
	Silty Sand, Gravel, and Cobbles		Silty Clay/Clay		Silt
	Sand and Gravel/Gravelly Sand		Silty Sand		Sand
					Boulder

AIR SPARGING
PILOT TEST REPORT
EAST HELENA FACILITY

WELL CONSTRUCTION
AND STRATIGRAPHY
FOR SPAR-3

FIGURE

2-6



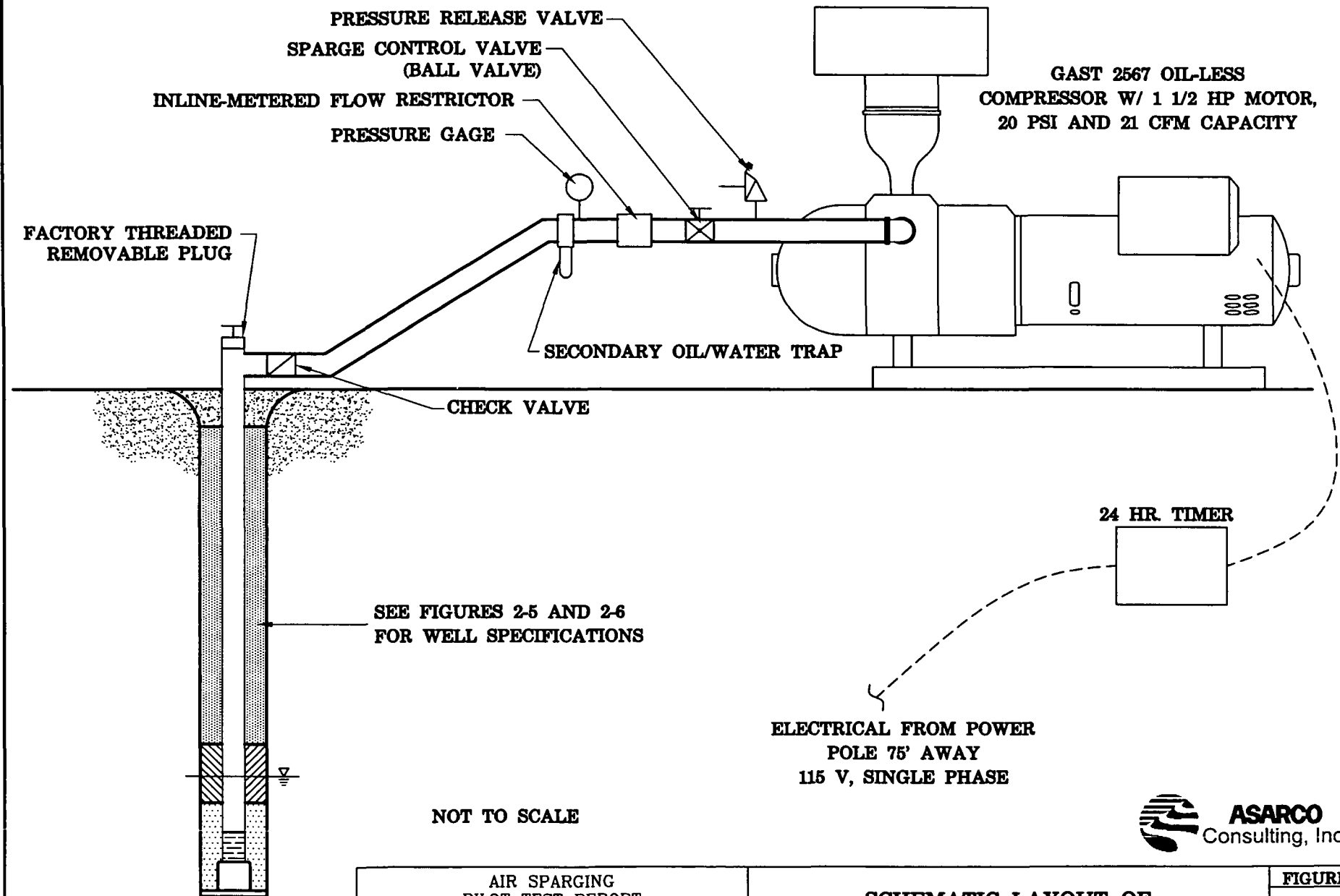
NOT TO SCALE

AIR SPARGING
PILOT TEST REPORT
EAST HELENA FACILITY

TYPICAL SHALLOW
MONITORING WELL CONSTRUCTION

FIGURE

2-7



AIR SPARGING
 PILOT TEST REPORT
 EAST HELENA FACILITY

SCHEMATIC LAYOUT OF
 AIR SPARGE SYSTEM

FIGURE

2-8

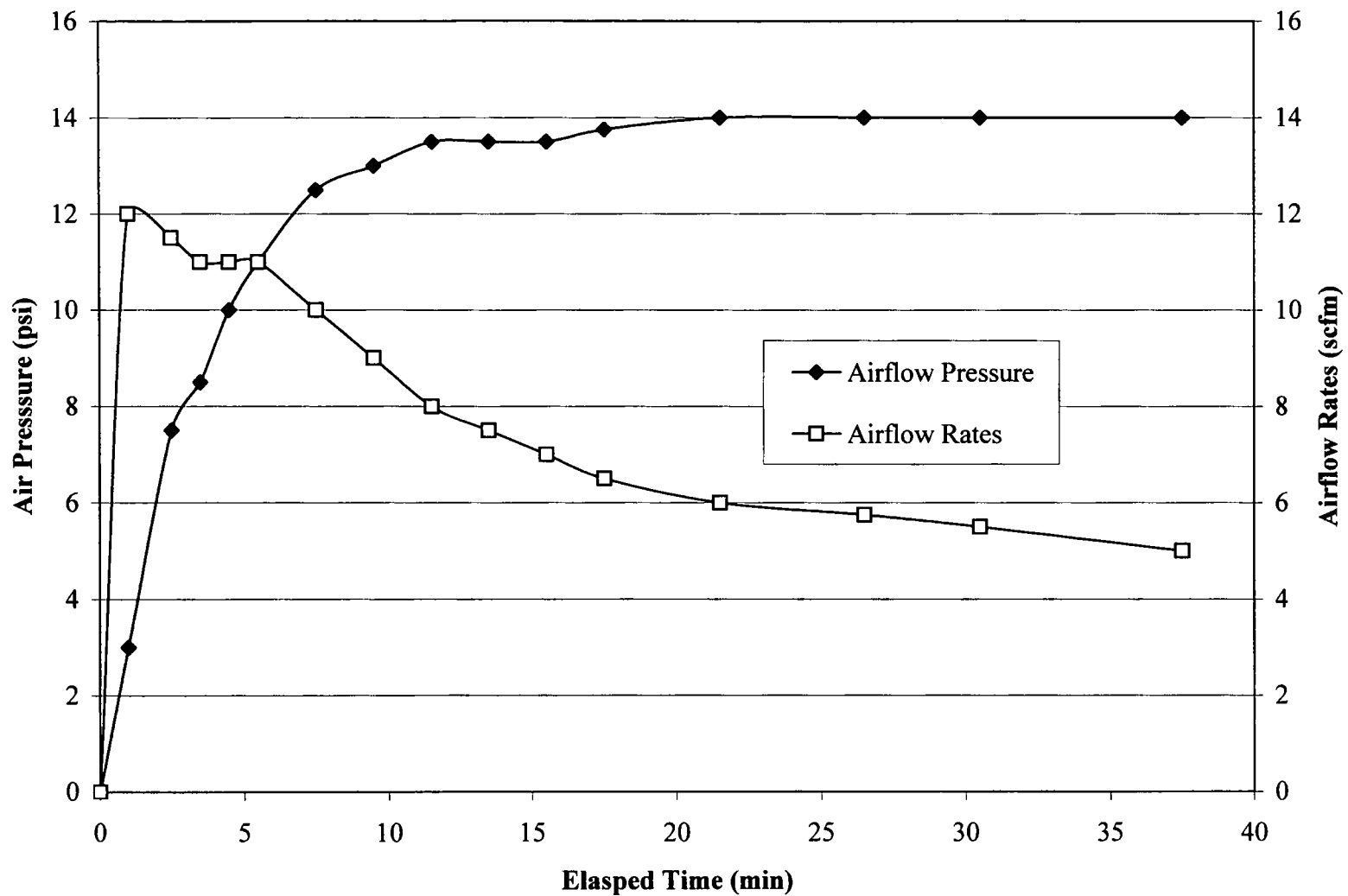


FIGURE 2-9. SPAR-2 AIRFLOW RESPONSE AT SYSTEM START-UP

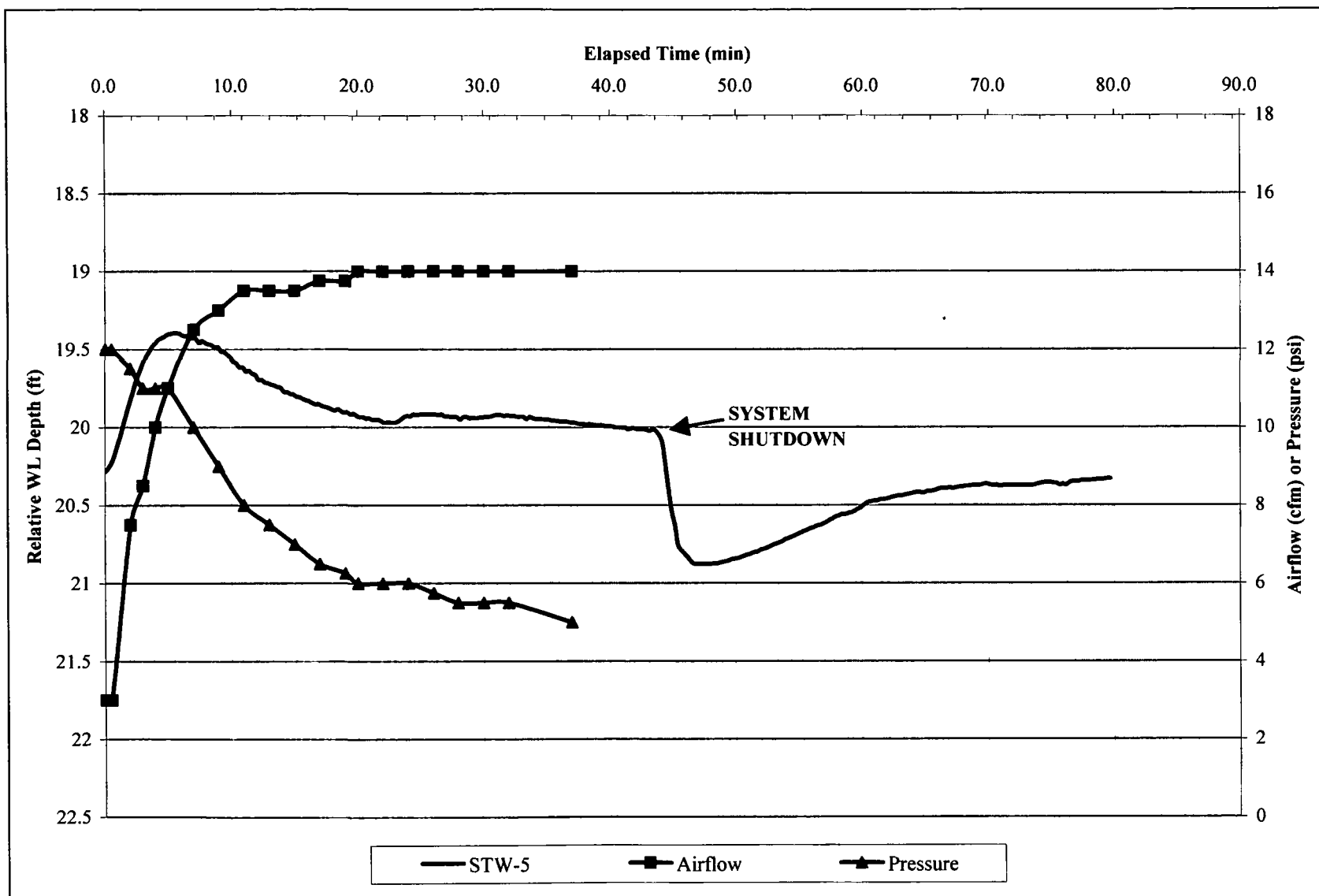
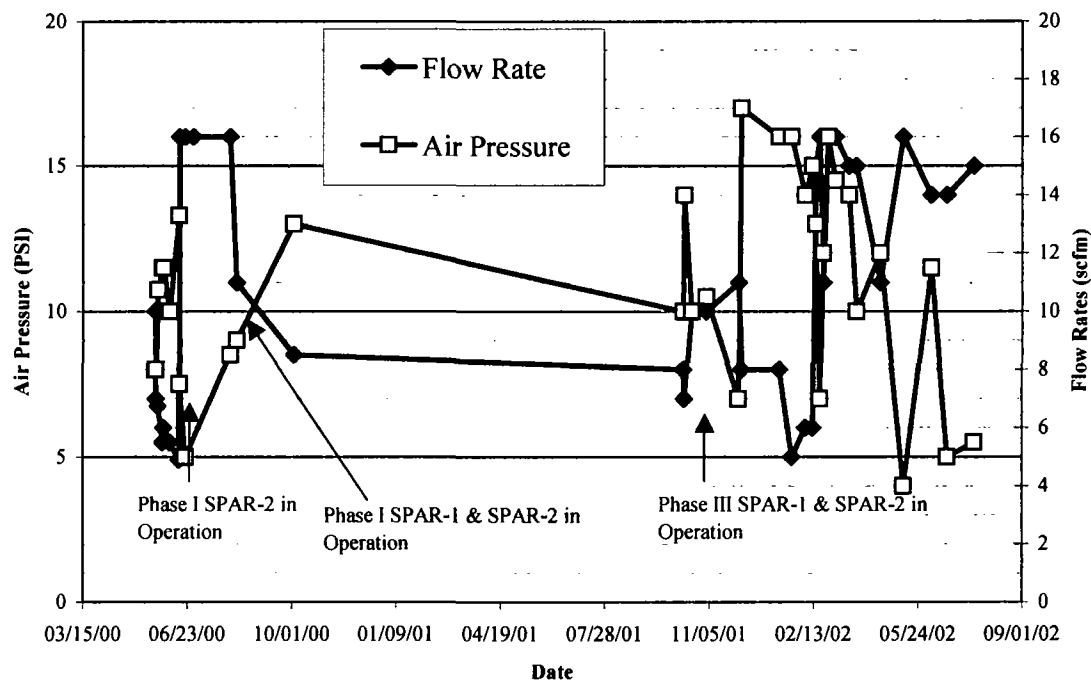


FIGURE 2-10. GROUNDWATER RESPONSE AT SYSTEM START-UP

SUMMARY OF AIRFLOW DATA PHASE I AND PHASE III TEST- SPARGE 1 AND SPARGE 2



SUMMARY OF AIRFLOW DATA PHASE I TEST AND PHASE III - SPARGE 3

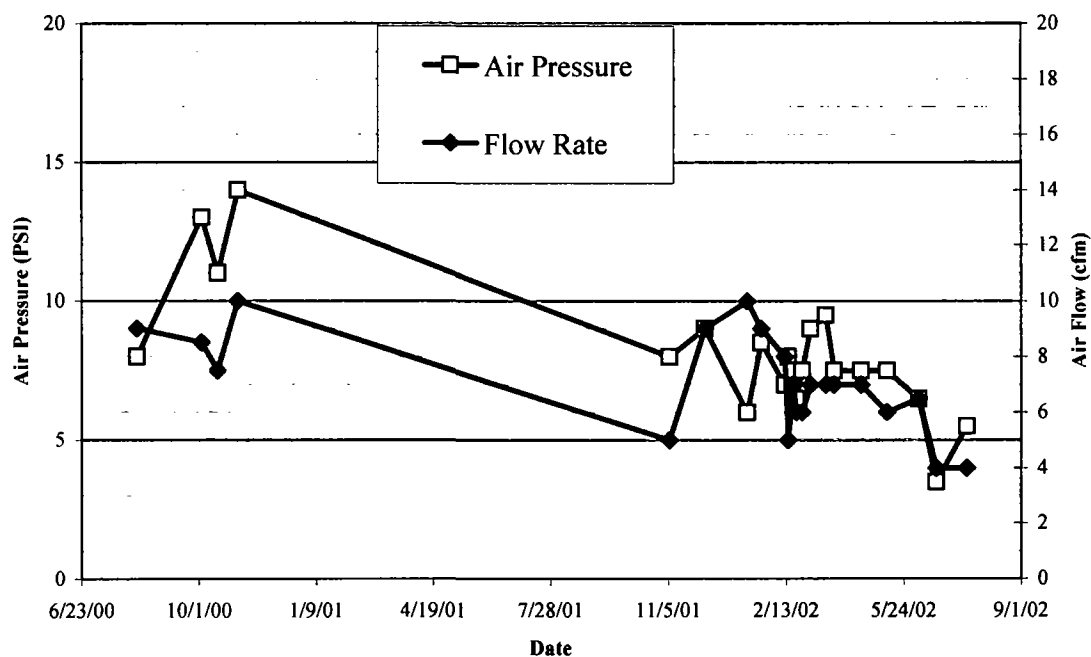


FIGURE 2-11. SUMMARY OF AIRFLOW DATA FROM SPARGE PILOT TESTS

Color Chart(s)

The following pages
contain color that does
not appear in the
scanned images.

To view the actual images, contact
the Region VIII Records Center at
(303) 312-6473.

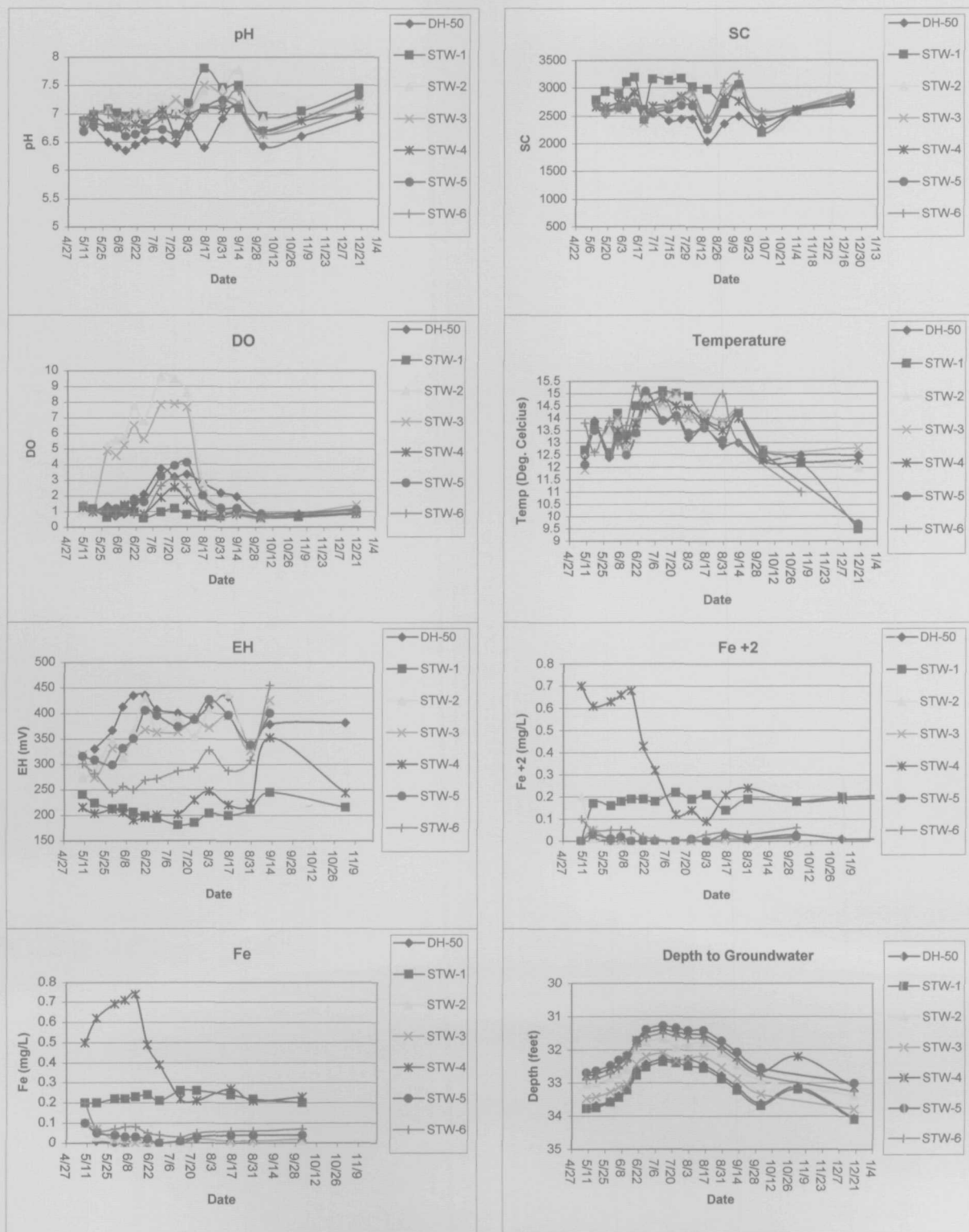


FIGURE 2-12. PHASE 1 SPAR 1 AND 2 PILOT TEST - FIELD PARAMETERS

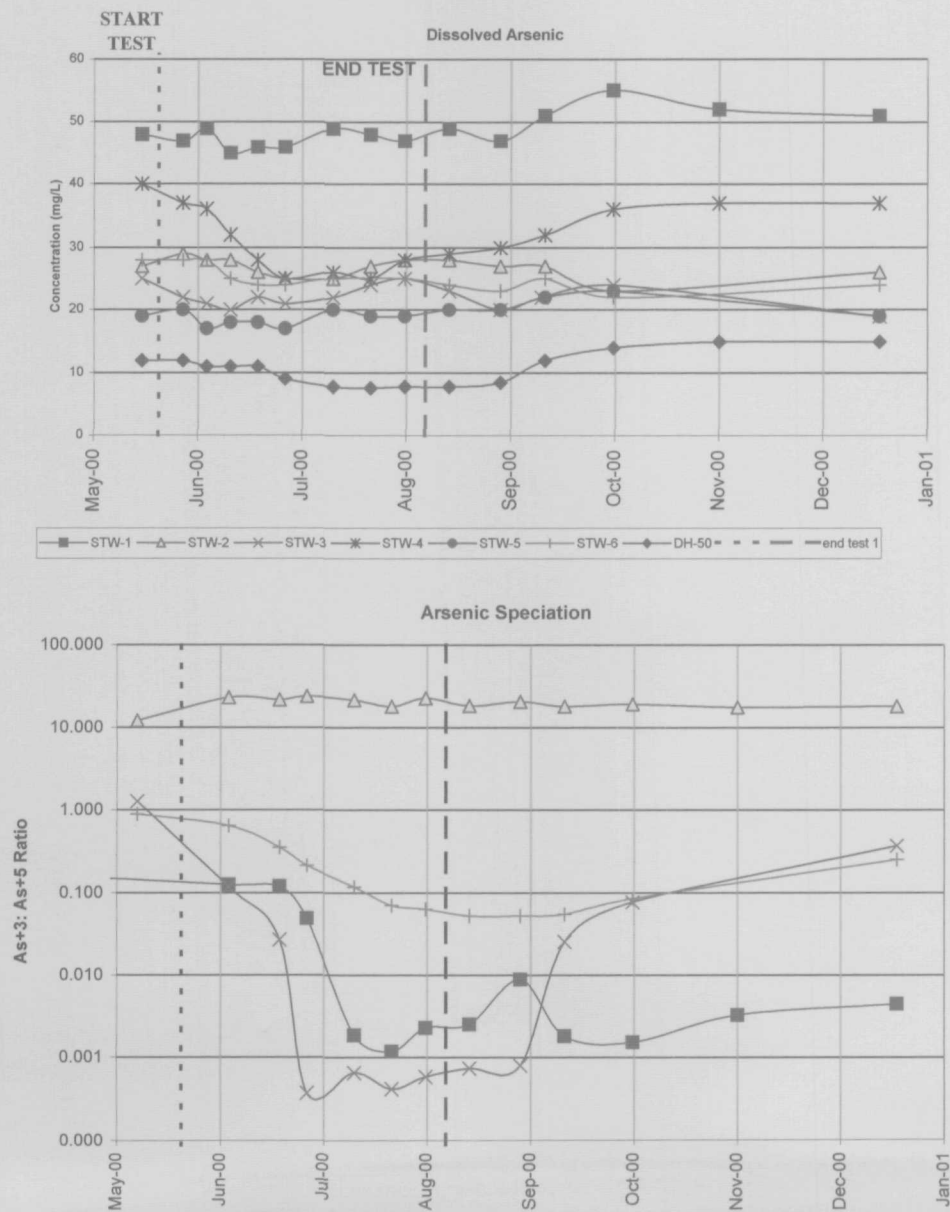


FIGURE 2-13. PHASE 1 SPAR-1 AND 2 PILOT TEST - ARSENIC CONCENTRATION GRAPHS

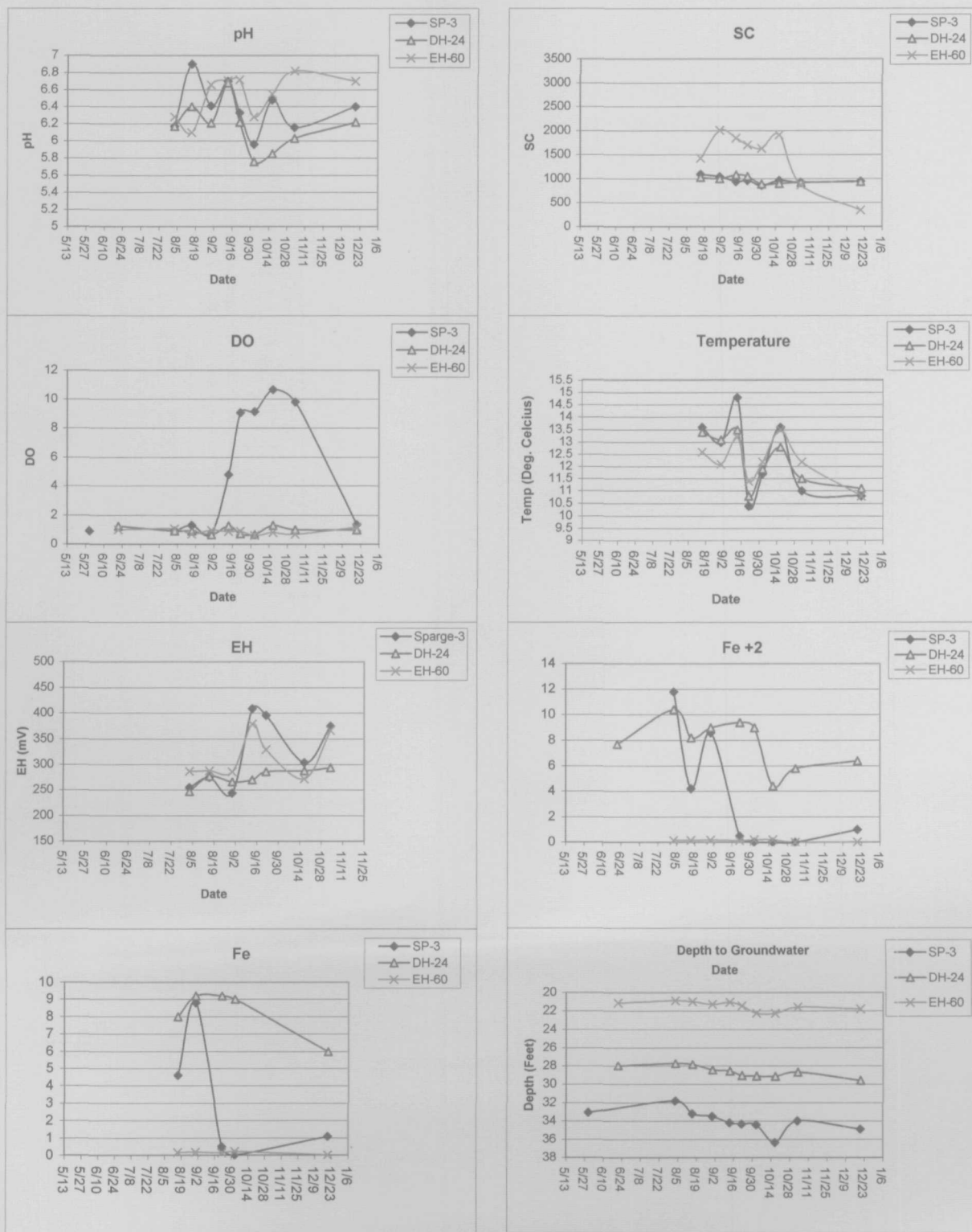


FIGURE 2-14. PHASE 1 SPAR-3 PILOT TEST - FIELD PARAMETERS

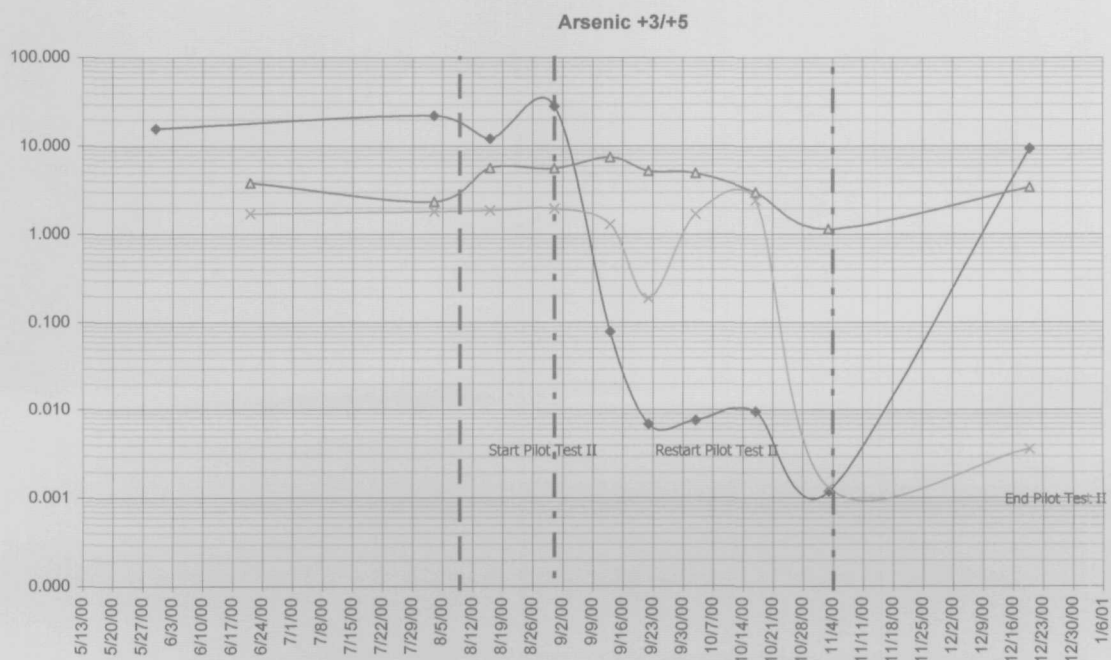
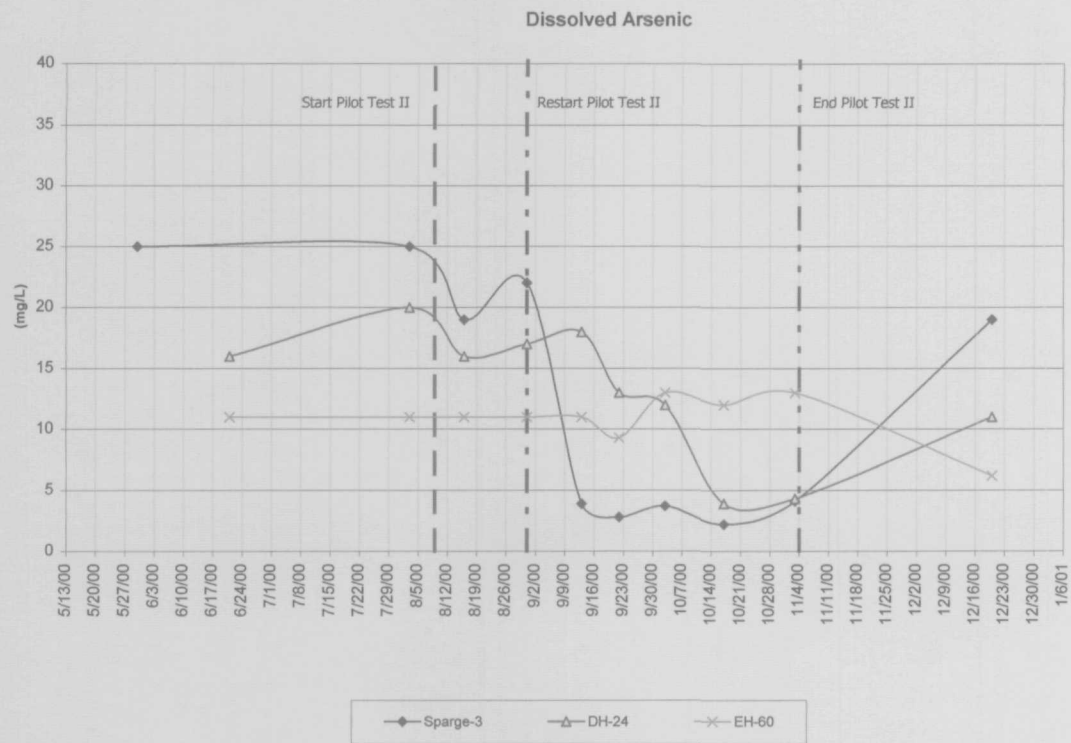


FIGURE 2-15. PHASE I SPAR 3 - ARSENIC CONCENTRATION GRAPHS

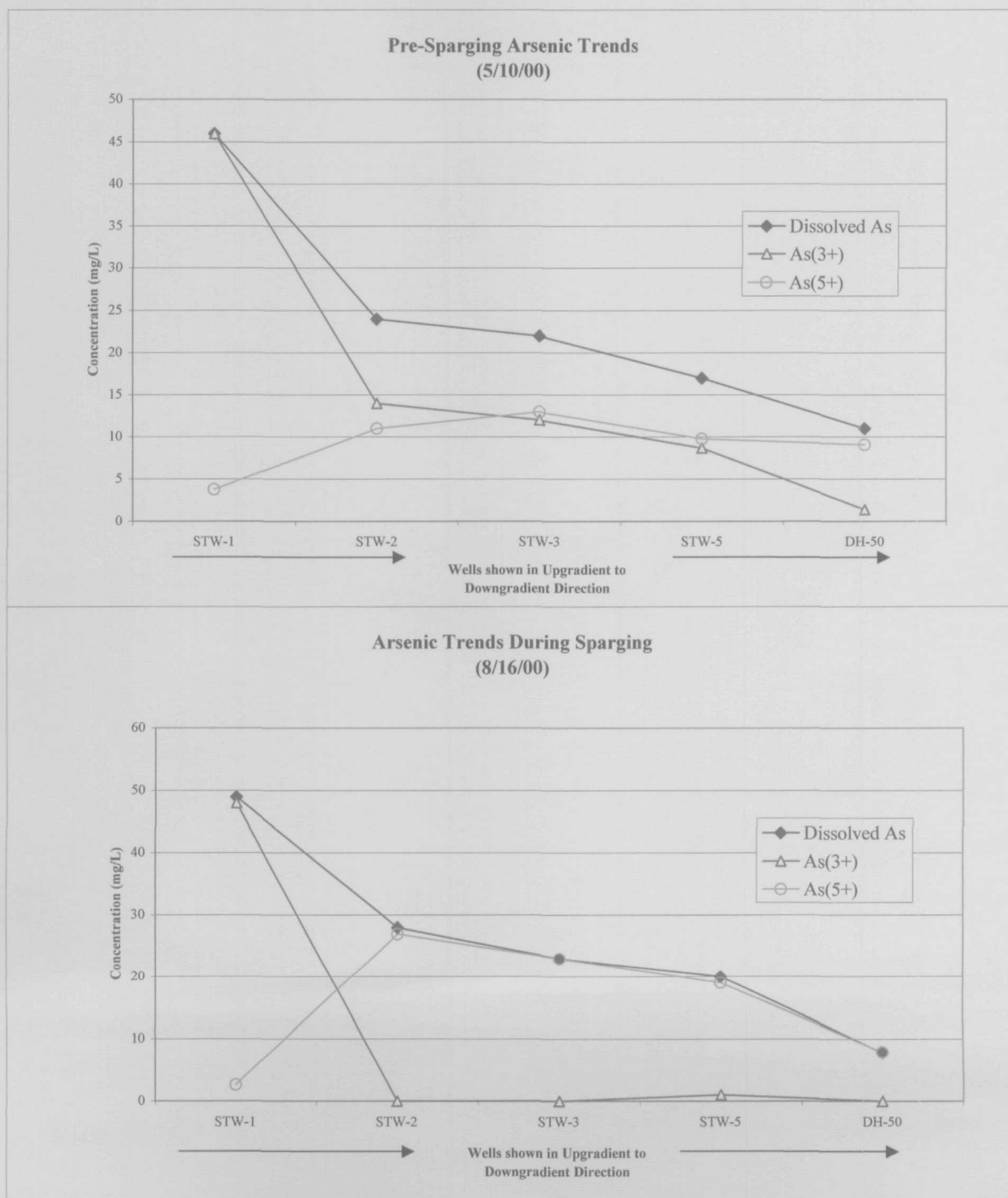
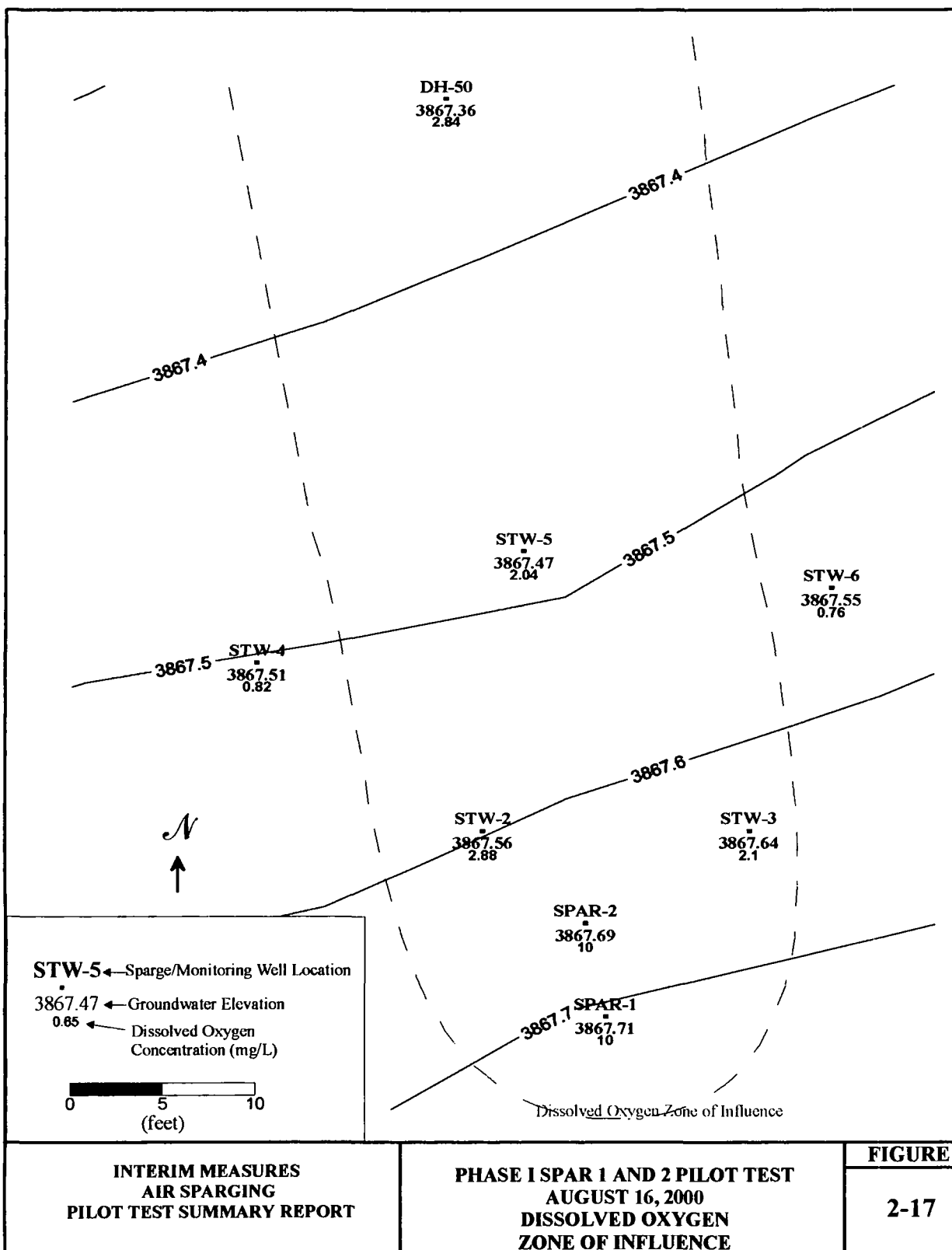
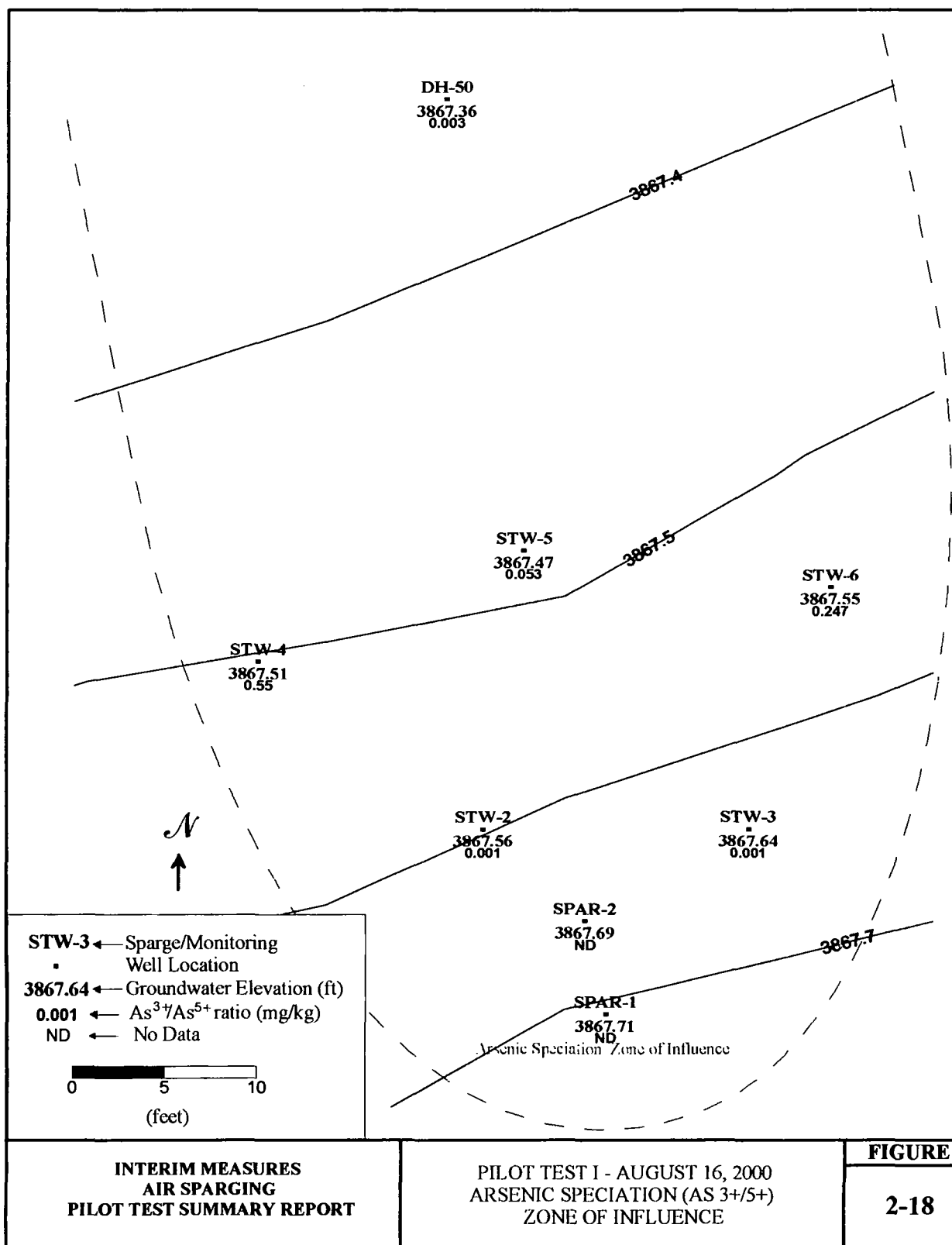


FIGURE 2-16. COMPARISON OF ARSENIC TRENDS IN GROUNDWATER PRE & POST TESTING





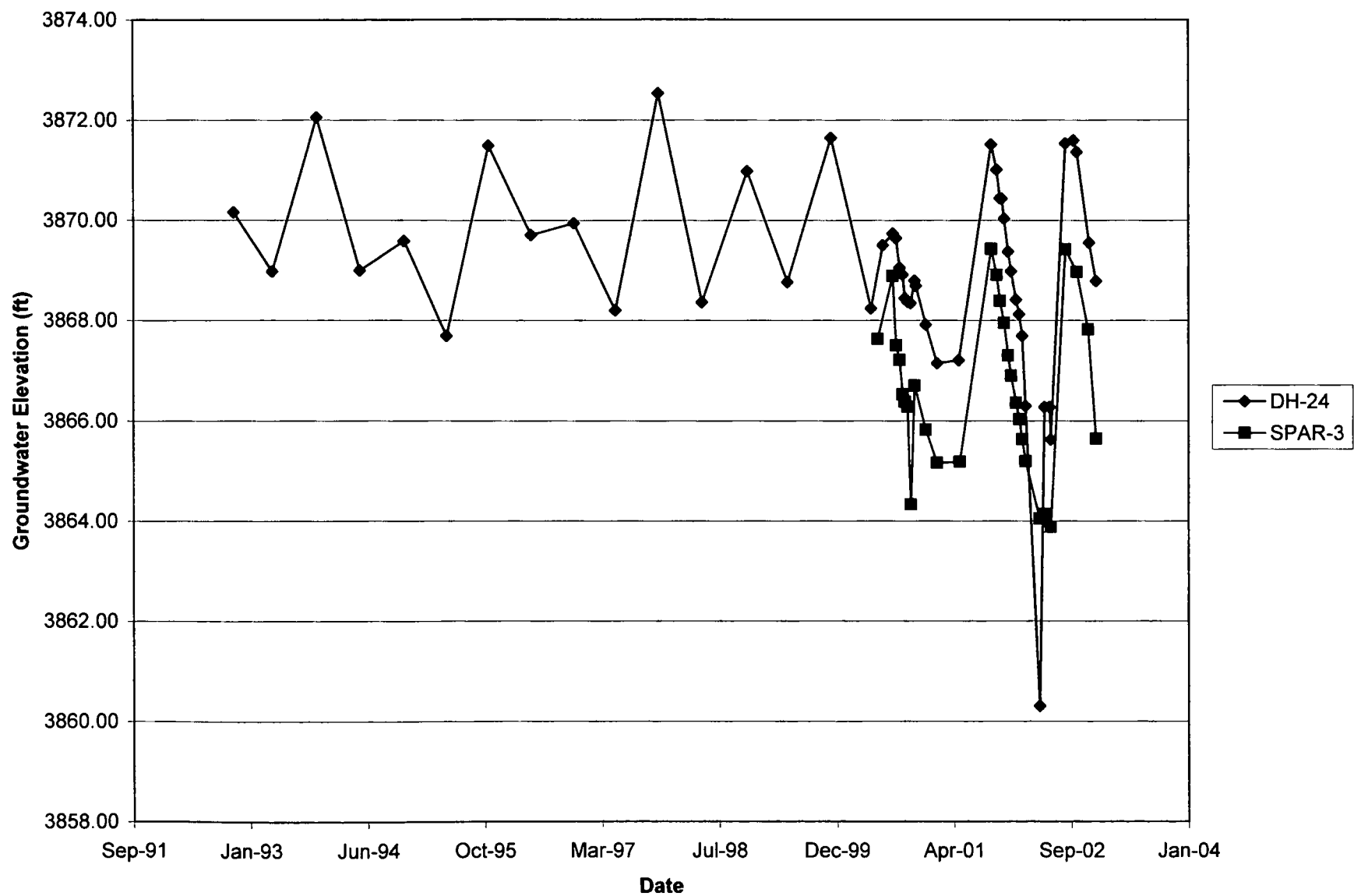
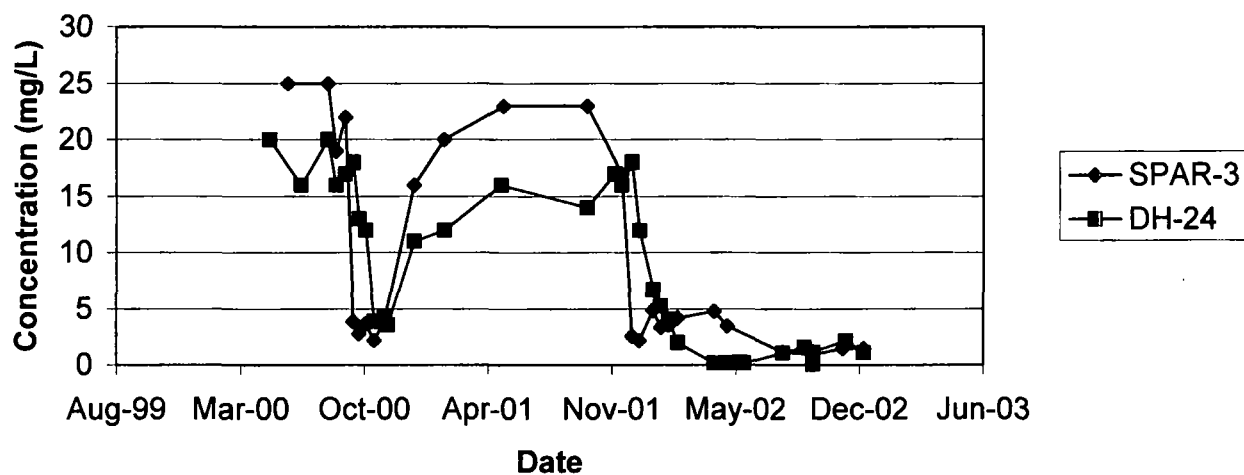


Figure 4-1. Water Level Trends at SPAR-3 Sparge System

Dissolved Arsenic Trend Plots For Sparge System Monitoring Wells SPAR-3 and DH-24



Dissolved Iron Trend Plots For Sparge System Monitoring Wells SPAR-3 and DH-24

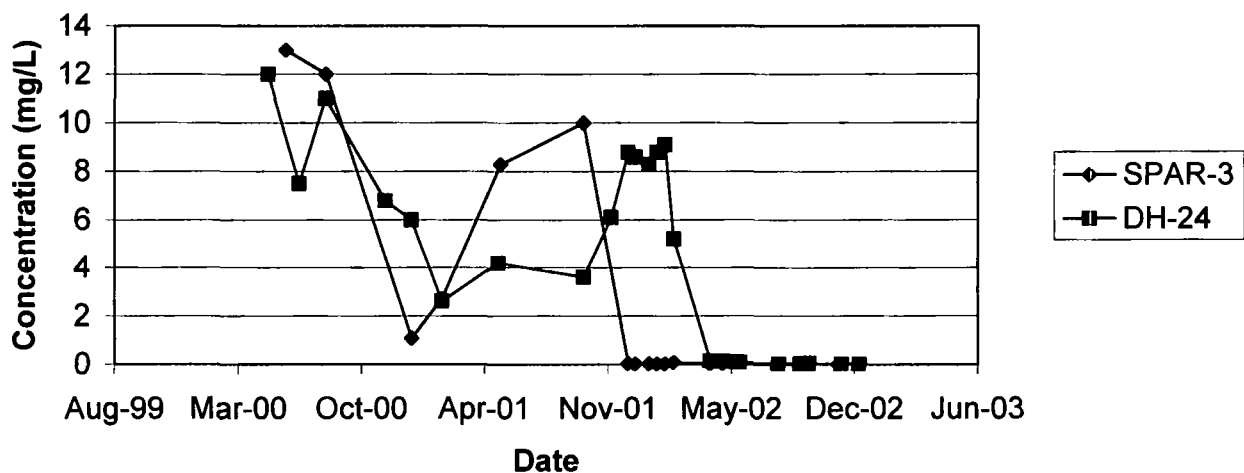
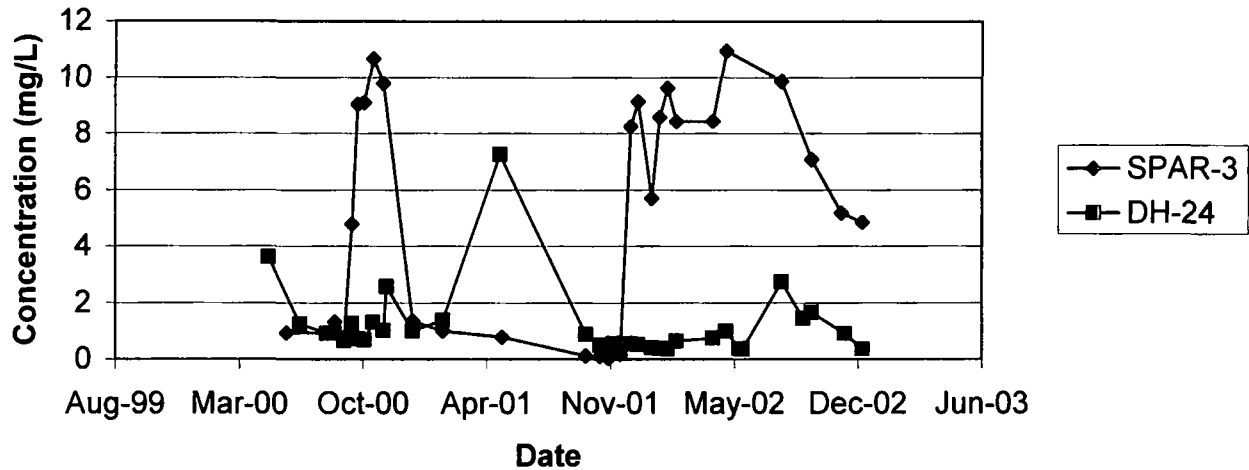


FIGURE 4-2. PHASE III WATER QUALITY TREND GRAPHS FOR SPAR-3 AND DH-24

Dissolved Oxygen Trend Plots For Sparge System Monitoring Wells SPAR-3 and DH-24



Sulfate Trend Plots For Sparge System Monitoring Wells SPAR-3 and DH-24

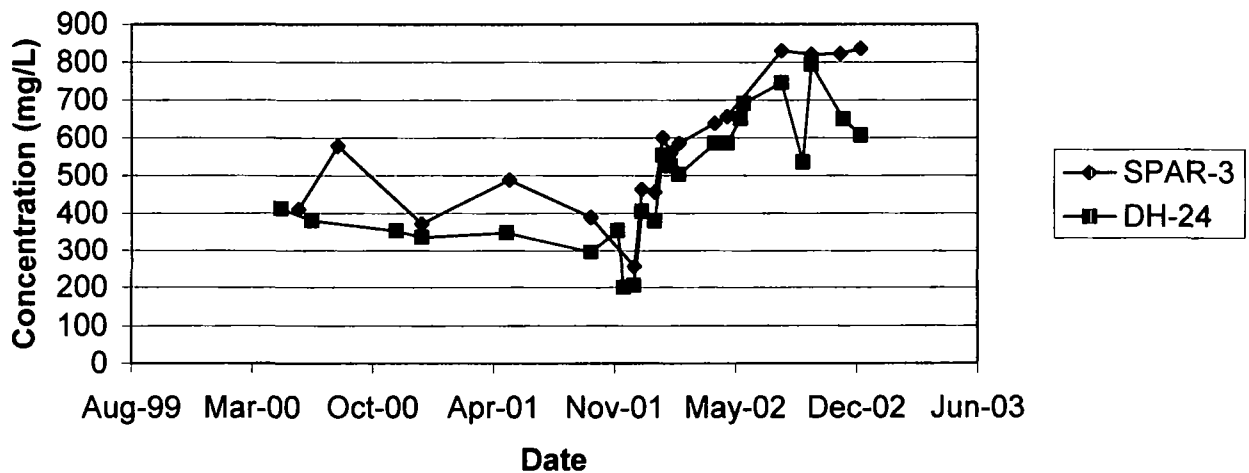


FIGURE 4-3. PHASE III WATER QUALITY TREND GRAPHS FOR SPAR-3 AND DH-24

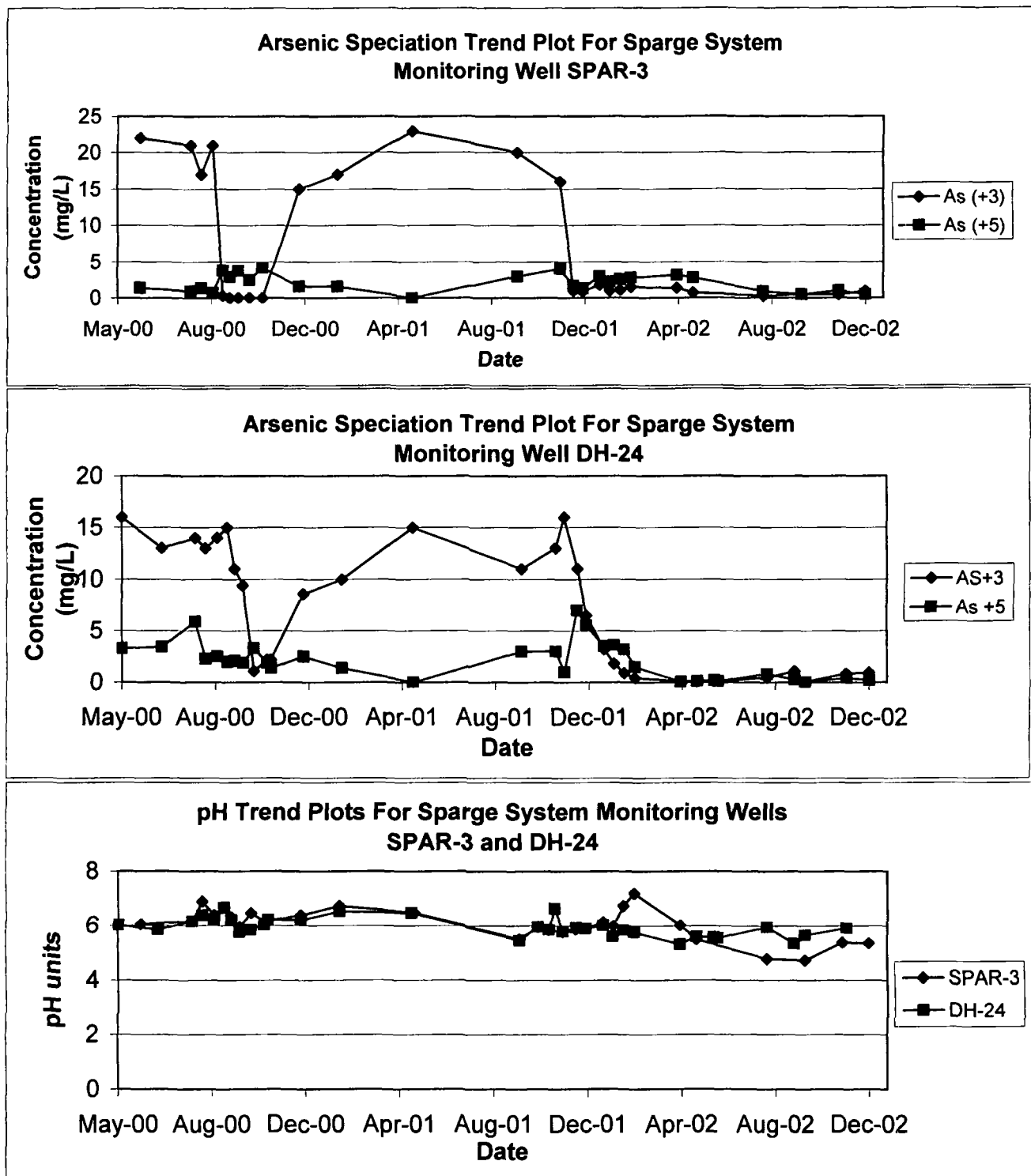


FIGURE 4-4. PHASE III WATER QUALITY TREND GRAPHS FOR SPAR-3 AND DH-24

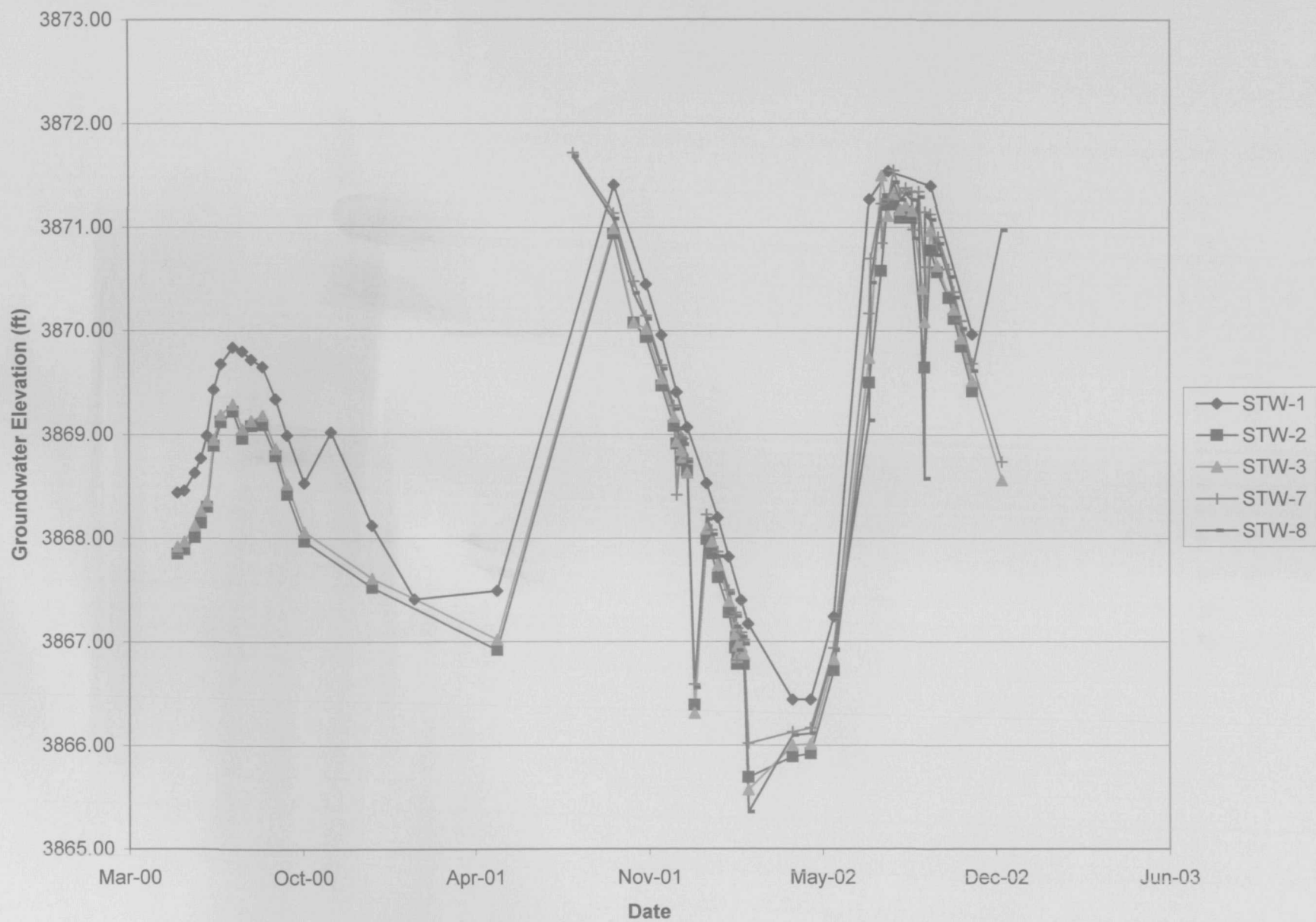


Figure 4-5. Water Level Trends at Upgradient Wells at SPAR-1 & SPAR-2 Sparge System

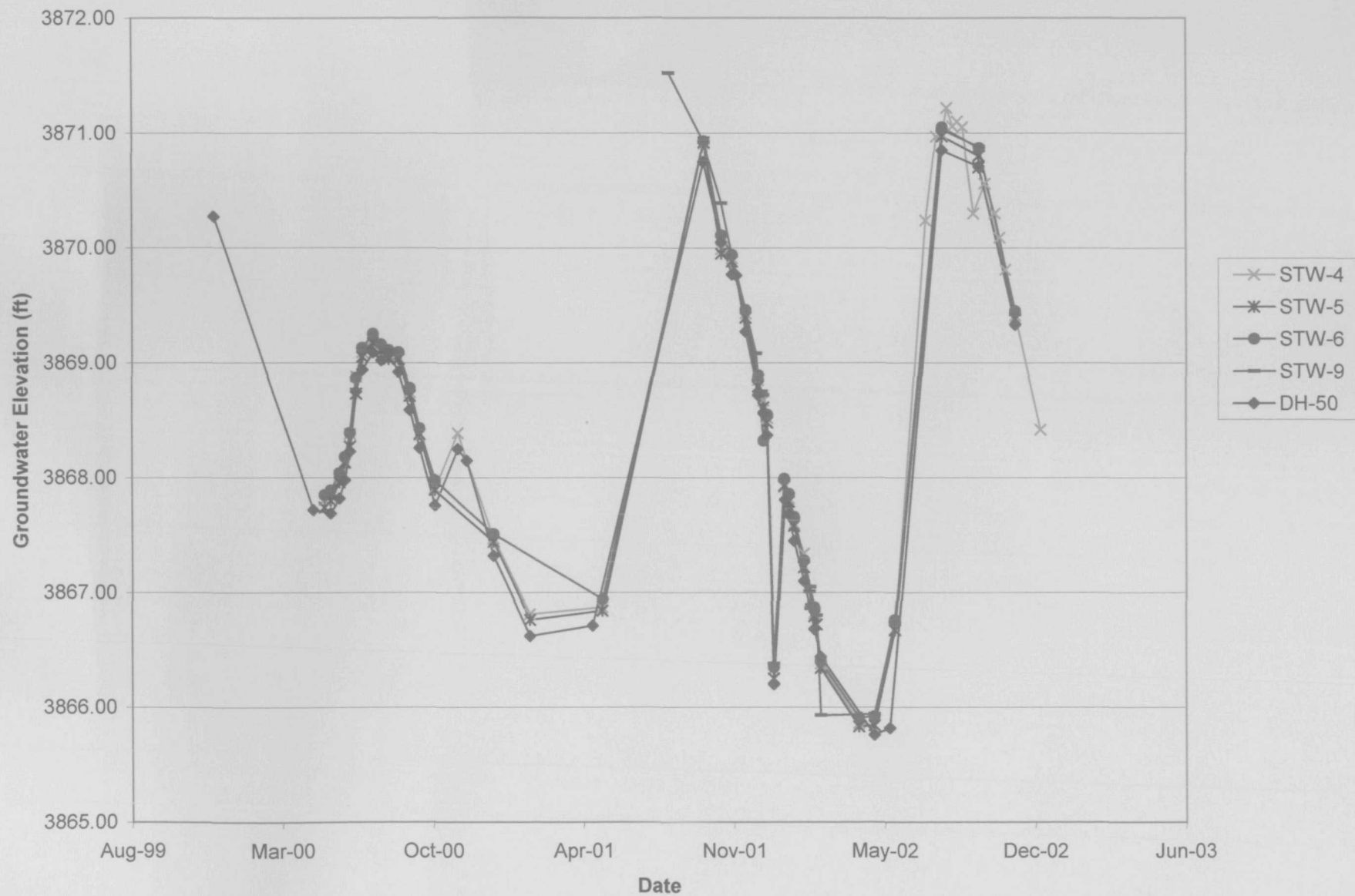
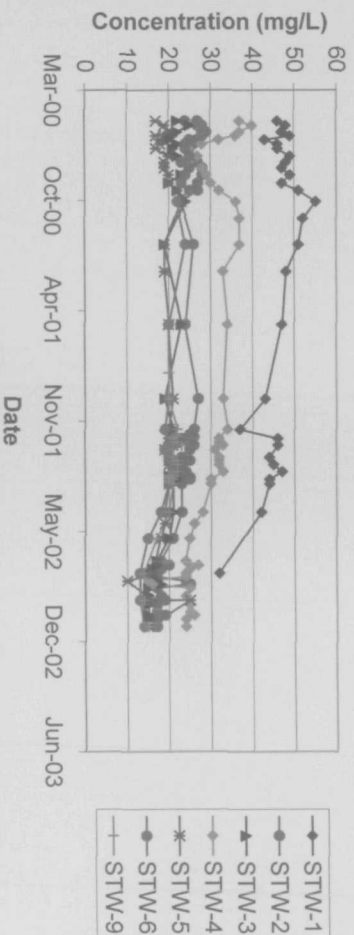
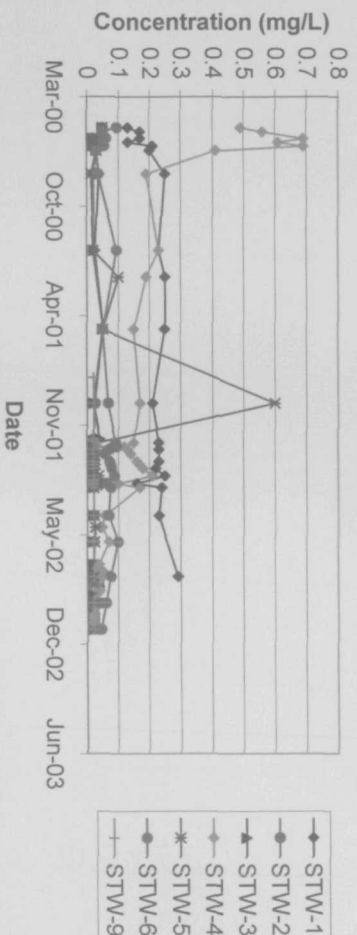


Figure 4-6. Water Level Trends at Downgradient Wells at SPAR-1 & SPAR-2 Sparge System

Dissolved Arsenic Trend Plots For Selected Sparge System Monitoring Wells



Dissolved Iron Trend Plots For Selected Sparge System Monitoring Wells

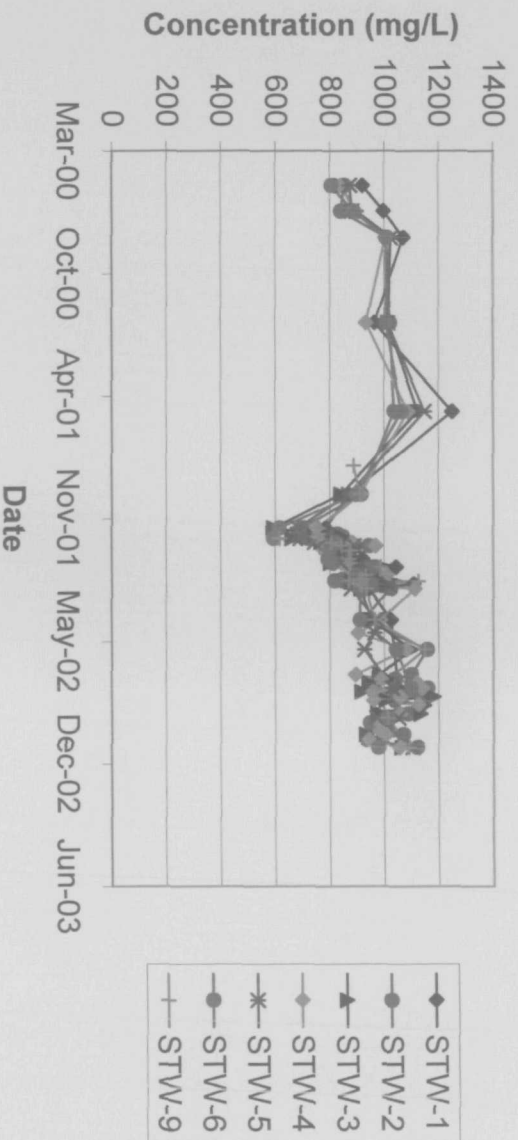


Dissolved Oxygen Trend Plots For Selected Sparge System Monitoring Wells



FIGURE 4-7. PHASE III WATER QUALITY TREND GRAPHS FOR STW-1 THROUGH
STW-6 AND STW-9

Sulfate Trend Plots For Selected Sparge System Monitoring Wells



pH Trend Plots For Selected Sparge System Monitoring Wells

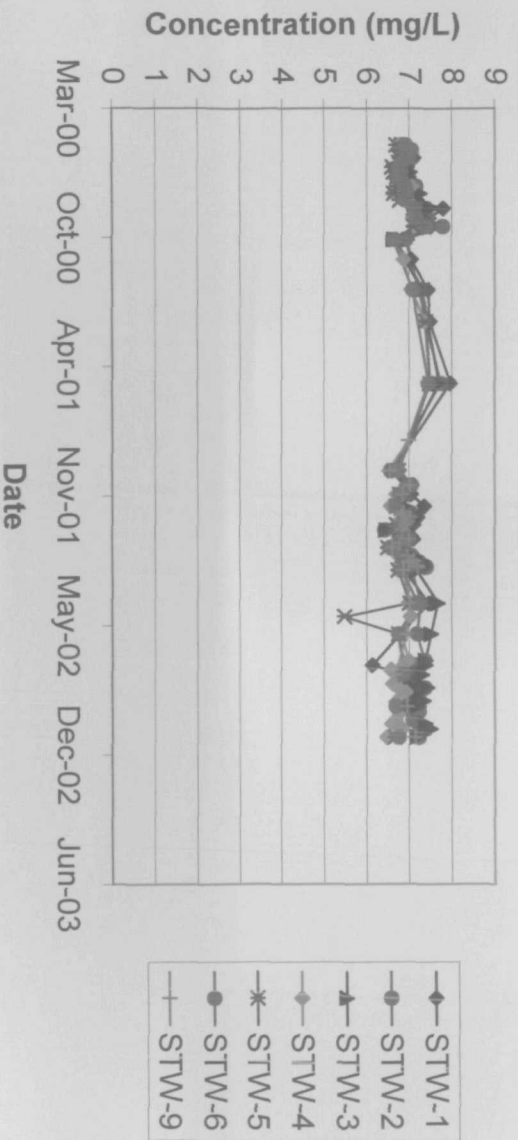
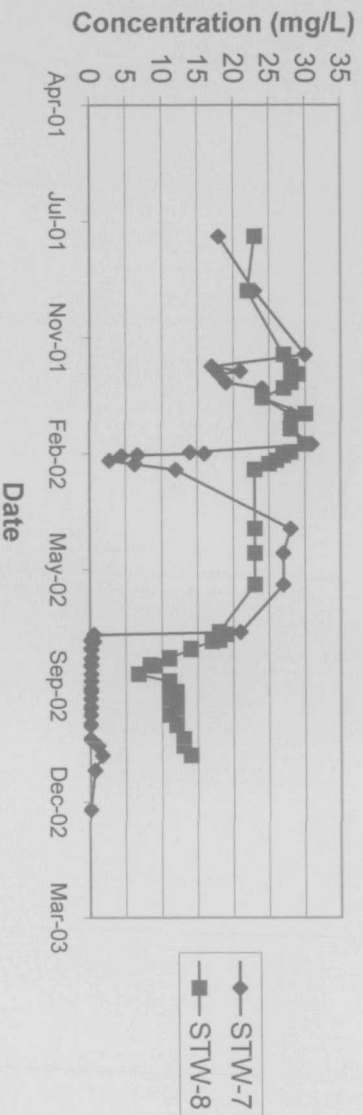
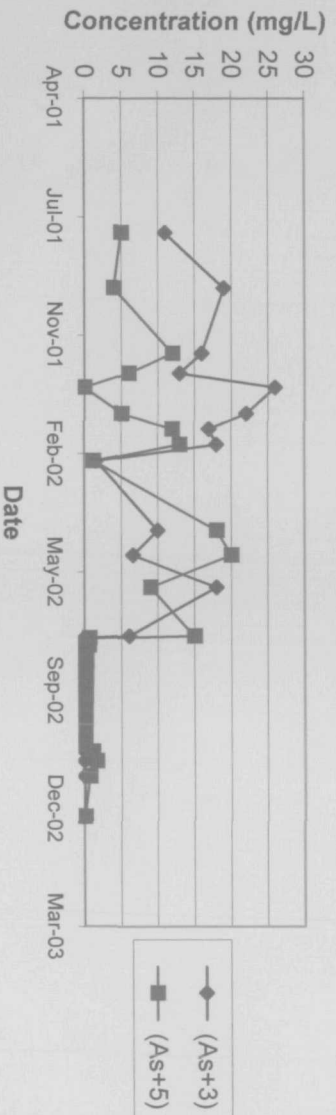


FIGURE 4-8. PHASE III WATER QUALITY TREND GRAPHS FOR STW-1 THROUGH STW-6 AND STW-9

Dissolved Arsenic Trend Plots For Sparge System Monitoring Wells STW-7 and STW-8



Arsenic Speciation Trend Plots For Sparge System Monitoring Well STW-7



Arsenic Speciation Trend Plots For Sparge System Monitoring Well STW-8

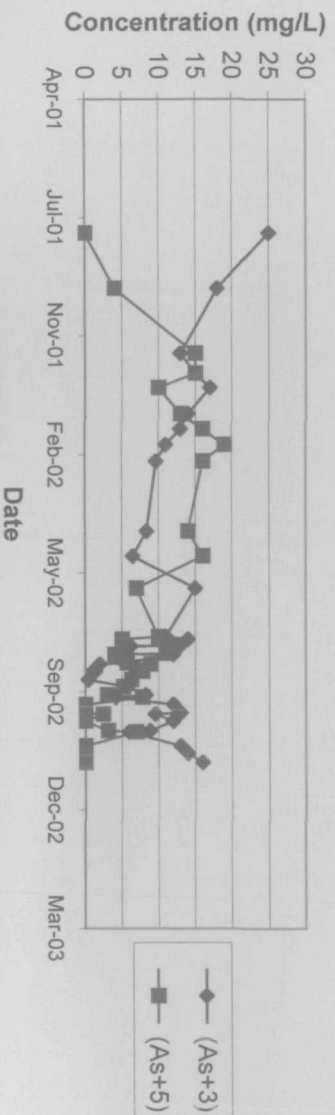
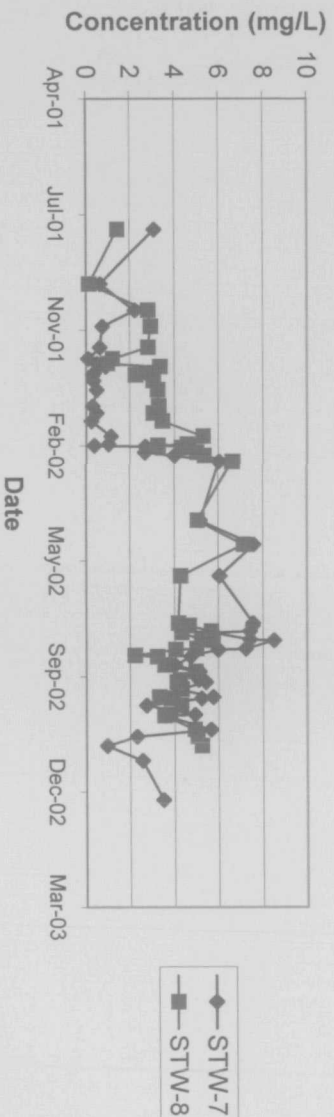


FIGURE 4-9. PHASE III WATER QUALITY TREND GRAPHS FOR STW-7 AND STW-8

Dissolved Oxygen Trend Plots For Sparge System Monitoring Wells STW-7 and STW-8



Sulfate Trend Plots For Sparge System Monitoring Wells STW-7 and STW-8

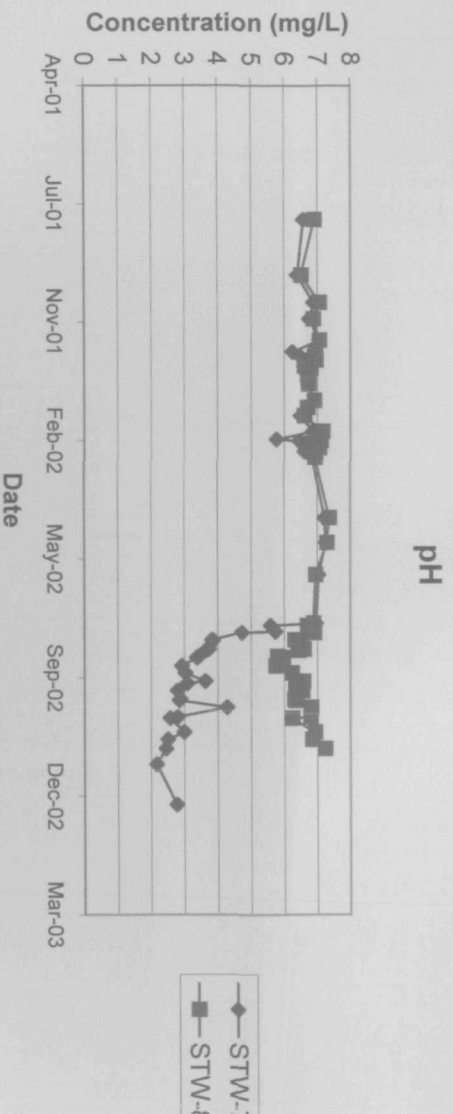
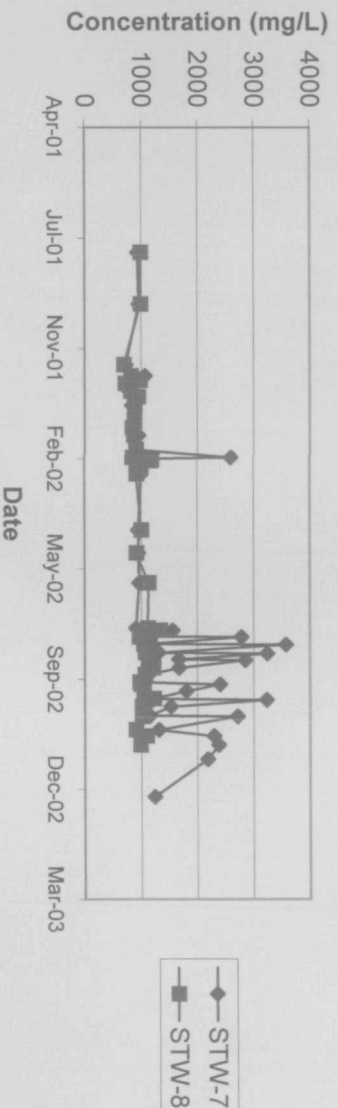
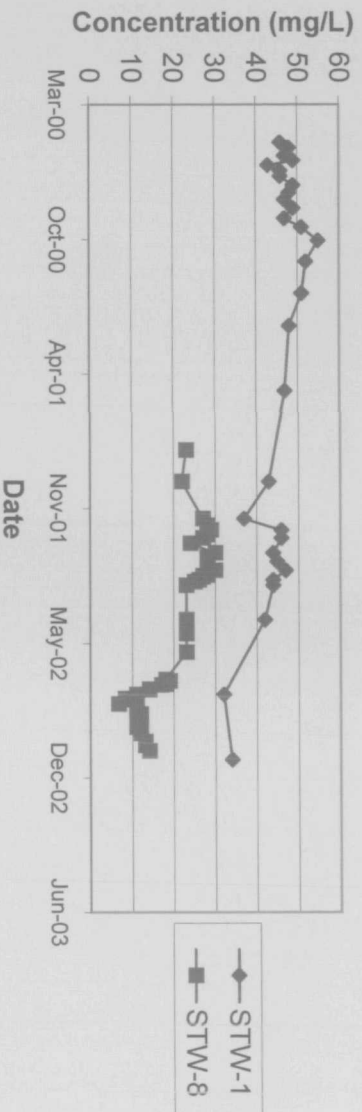
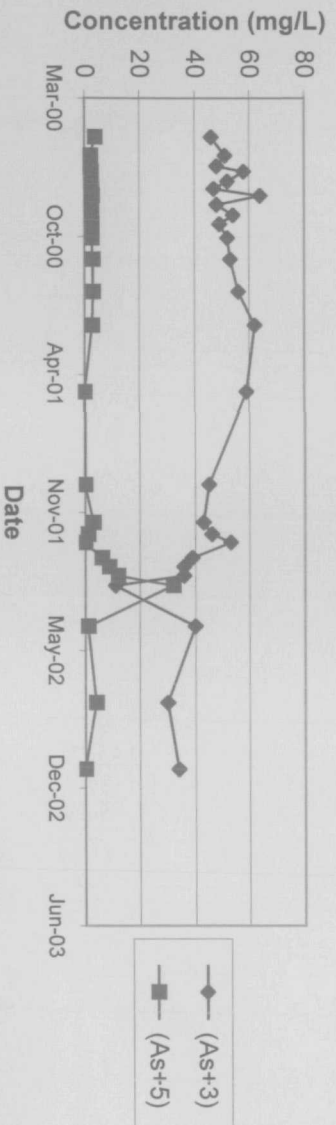


FIGURE 4-10. PHASE III WATER QUALITY TREND GRAPHS FOR STW-7 AND STW-8

Dissolved Arsenic Trend Plots For Sparge System Monitoring Wells STW-1 and STW-8



Arsenic Speciation Trend Plots For Sparge System Monitoring Well STW-1



Arsenic Speciation Trend Plots For Sparge System Monitoring Well STW-8

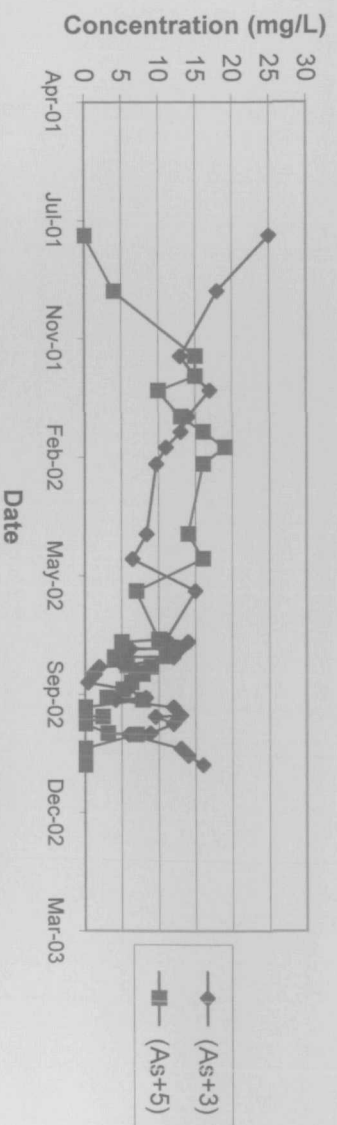
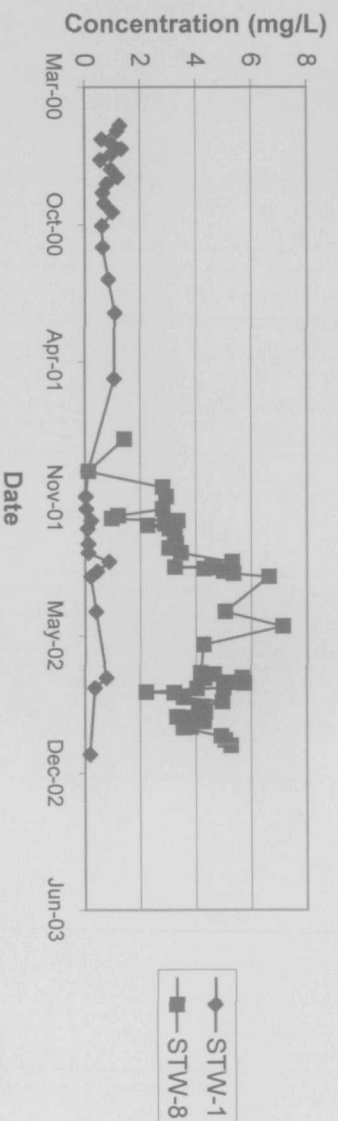
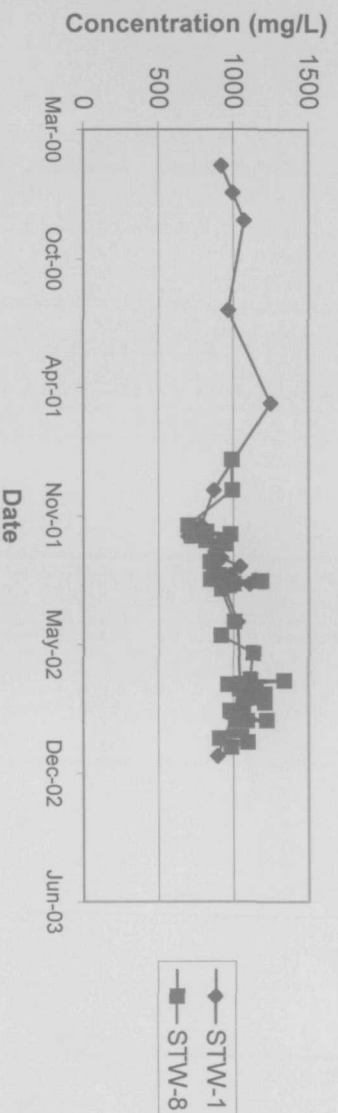


FIGURE 4-11. PHASE III WATER QUALITY TREND GRAPHS FOR STW-1
AND STW-8

Dissolved Oxygen Trend Plots For Sparge System Monitoring Wells STW-1 and STW-8



Sulfate Trend Plots For Sparge System Monitoring Wells STW-1 and STW-8



pH Trend Plots For Sparge System Monitoring Wells STW-1 and STW-8

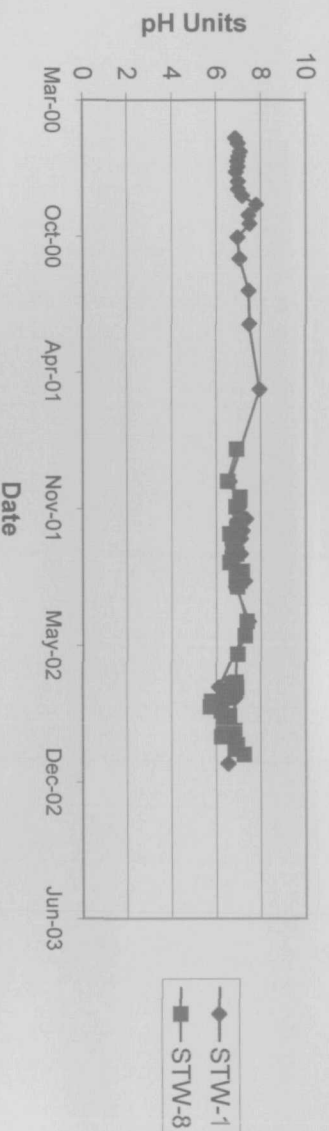


FIGURE 4-12. PHASE III WATER QUALITY TREND GRAPHS FOR STW-1 AND STW-8

APPENDIX A

WELL LITHOLOGIC/CONSTRUCTION LOGS

AND

WELL DEVELOPMENT LOGS

ASARCO CONSULTING INC.

Air Sparging Well

Hole Name: SPAR-1

Date Hole Started: 4/26/2000 Date Hole Finished: 4/27/00

Client: ASARCO, INC.

Project: Interim Measures East Helena Facility

County: Lewis and Clark State: Montana

Property Owner: Asarco Inc.

Legal Description: NW,NW,NE Sec 36 T10N, R3W

Descriptive Location: South of American Chemet

Recorded By: JR

Drilling Company: Hydrometrics, Inc.

Driller: Ron Meinstra

Drilling Method: Air Rotary/ODEX

Drilling Fluids Used: Water

Purpose of Hole: Air Sparging Well

Target Aquifer: First Water

Hole Diameter (In): 6

Total Depth Drilled (ft): 40

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	2-inch, flush threaded, Sch 40, PVC	+2.7-40
Surface Casing Used?	Y	5-inch steel	+3 to -2
Screen/Perforations?	Y	0.010-inch slot, Sch 40, PVC	36.8-38.8
Sand Pack?	Y	10-20 silica sand	37-40
Annular Seal?	Y	Bentonite Pellets/Bentonite Grout	34.5-37 chips, 0-37 bentonite
Surface Seal?	Y	Cement	0-0.5
DEVELOPMENT/SAMPLING			
Well Developed?	Y	pumping	
Water Samples Taken?	Y	common ions, metals	
Boring Samples Taken?	Y	lithologic identification	

Static Water Level Below MP: 33.21

Surface Casing Height (ft): 3.0

Date: 5/23/00

Riser Height (ft): 2.7











MP Description: Top of PVC

Ground Surface Elevation (ft): 3898.72

MP Height Above or Below Ground (ft): 2.65

MP Elevation (ft): 3901.37

Remarks: All soil descriptions and size fraction distributions based on field observations and tests; Depth water encountered: Approx. 31 feet; set screen from 38-40', however, PVC casing got pulled upward while extracting ODEX casing. Screen moved upward approx. 1.2 feet.

DEPTH	SAMPLE NUMBER	SAMPLE TYPE	BLOW COUNT	RECOVERY (feet)	DRILLING AND GEOTECHNICAL NOTES	GRAPHICS	GEOLOGICAL DESCRIPTION
5	0004--119	SS	20,50-5"	0.50	5.0 - 7.0'		0.0 - 5.0' Sand and Gravel brown, fine to coarse sand, unconsolidated, poorly sorted, 30-40% fine to coarse size gravels, dry. [GWS]
10	0004--120	SS	25,50-5"	0.70	10.0 - 12.0'		5.0 - 6.0' Gravelly silty sand Brown, fine grained, silty, 20% silt, well to moderately sorted, loose, 15% gravel, fine to medium, moist. [SM]
15	0004--121	SS	46-5"	0.20	15.0 - 17.0'		10.0 - 11.0' Sandy gravel Black, brown, orange brown, 2-3" size angular basalt gravel, 25% sand, fine to coarse grain, poorly sorted, dry. [GWS]
20	0004--122	SS	25,50-4"	0.30	20.0 - 22.0'		11.0 - 15.0' Cobbles and sand Black, abundant cobbles from 11 to 15 feet, sand is fine to coarse grain, dry, very difficult drilling. [GPS]
25	0004--123	SS	no sample	0.00	25.0 - 27.0'		15.0 - 17.0' Sandy gravel Gray, silty, 1 to 3" gravel, very fine grained sand, poor spoon recovery, dry. [GM]
30	0004--124	SS	25,50-	0.30	28.0 - 30.0'		17.0 - 20.0' Sandy Gravel Very cobbly, very difficult drilling, dry. [GPS]
35	0004--125	SS	50-2"	0.10	30.0 - 32.0'		20.0 - 22.0' Gravelly silty sand Gray, orange brown, fine grain, 25% silt, moderately sorted, 1-3" size gravel, abundant basalt gravel, dry. [SGM]
40	0004--126	SS	7,17,30,42	1.80	32.0 - 34.0'		22.0 - 25.0' Sandy gravel Abundant cobbles, encountered boulder at 25 feet, difficult drilling, driller adding water. [GWS]
45	0004--127	SS	12,10,6,7	1.70	34.0 - 36.0'		25.0 - 28.0' Sandy gravel Black, gray, 1-3" size gravel, boulder at 25-26'; clayey fine grained sand from 26-27'. [GWS]
50	0004--128	SS	3,9,19,50-5"	1.40	36.0 - 38.0'		28.0 - 30.0' Gravelly silty sand Brown, orange brown, fine to coarse grain, poorly sorted, 10% silt, 15% gravel. [GWS]
55	0004--129	SS	2,16,33,50	1.60	39.0 - 41.0'		
60							

Continued Next Page

Sheet 1 of 2

GEOTECH 1054 GPT HYD-TUC.GDT 1/16/03

ASARCO CONSULTING INC.

Air Sparging Well

Hole Name: SPAR-1

Date Hole Started: 4/26/2000 Date Hole Finished: 4/27/00

(Continued)

DEPTH	SAMPLE NUMBER	SAMPLE TYPE	BLOW COUNT	RECOVERY (feet)	DRILLING AND GEOTECHNICAL NOTES	GRAPHICS	GEOLOGICAL DESCRIPTION
65							coarse gravel, loose, poor recovery. [SGM]
65							30.0 - 32.0' Silty sand gravel Brown, 1-2" size angular gravel, cobbly, 20% silt, 20% fine sand, very poor recovery. [GWS]
70							32.0 - 34.0' Silty gravelly sand Brown, orange brown, brown, black green very fine to medium grain, moderately sorted, 15-20% silty, trace clayey in part, slightly loose to medium dense, 5-10% gravel, fine to coarse, wet. [SGM]
75							34.0 - 36.0' Gravelly silty sand 34-35' gravelly silty sand, brown, fine grain, 15% silt, moderately sorted medium dense, trace clay, making lots of water, 35-36' silty clay, brown firm to stiff, medium plasticity, borehole quits yielding water. [SGM]
80							36.0 - 38.0' Sand Light brown, fine grain, 5% medium grain, moderately sorted, loose, 5-10% silt, making lots of water at 38'. [SP-SM]
85							38.0 - 39.0' Sand Sand, brown, medium grain, well sorted, loose, making lots of water, 5% fines. [SP]
90							39.0 - 41.0' Sand 39-40' sand, fine to medium grain, moderately sorted, loose, making lots of water. 40-41' silty sandy gravel as above. [SP]
95							
100							
105							
110							
115							
120							
125							
130							
135							
140							
145							
150							
155							

GEOTECH 1054.GPJ HYD-TUC.GDT 1/16/03

ASARCO CONSULTING INC.

Air Sparging Well

Hole Name: SPAR-2

Date Hole Started: 4/28/2000 Date Hole Finished: 4/28/2000

Client: ASARCO, INC.

Project: Interim Measures East Helena Facility

County: Lewis and Clark State: Montana

Property Owner: Asarco Inc.

Legal Description: NW,NW,NE Sec 36 T10N, R3W

Descriptive Location: South of American Chemet

Recorded By: JR

Drilling Company: Hydrometrics, Inc.

Driller: Ron Meinstma

Drilling Method: Air Rotary/ODEX

Drilling Fluids Used: Water

Purpose of Hole: Air Sparging Well

Target Aquifer: First Water

Hole Diameter (in): 6

Total Depth Drilled (ft): 41

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	2-inch, flush threaded, Sch 40, PVC	+3.2-31
Surface Casing Used?	Y	5-inch steel	+3 to -2
Screen/Perforations?	Y	0.010-inch slot, Sch 40, PVC	36-39
Sand Pack?	Y	10-20 silica sand	35-41
Annular Seal?	Y	Bentonite Pellets/Bentonite Grout	32-35 pellets, 0-32 bentonite
Surface Seal?	Y	Cement	0-0.5
DEVELOPMENT/SAMPLING			
Well Developed?	Y	pumping	
Water Samples Taken?	Y	common ions, metals	
Boring Samples Taken?	Y	lithologic identification	

Static Water Level Below MP: 33.39

Surface Casing Height (ft): 3.4

Date: 5/23/00

Riser Height (ft): 3.2

MP Description: Top of PVC

Ground Surface Elevation (ft): 3898.44

MP Height Above or Below Ground (ft): 3.07

MP Elevation (ft): 3901.51

Remarks: All soil descriptions and size fraction distributions based on field observations and tests; Samples collected with 3-inch diameter spoons on 2 7/8-inch rods, driven by a 300 lb/30-inch drop auto hammer.

DEPTH	SAMPLE NUMBER	SAMPLE TYPE	BLOW COUNT	RECOVERY (feet)	DRILLING AND GEOTECHNICAL NOTES	GRAPHICS	GEOLOGICAL DESCRIPTION
5							0.0 - 5.0' Sand and Gravel brown, fine to coarse sand, unconsolidated, poorly sorted, 30-40% fine to coarse size gravels, dry. [GWS]
10							5.0 - 6.0' Gravelly silty sand Brown, fine grained, silty, 20% silt, well to moderately sorted, loose, 15% gravel, fine to medium, moist. [SM]
15							10.0 - 11.0' Sandy gravel Black, brown, orange brown, 2-3" size angular basalt gravel, 25% sand, fine to coarse grain, poorly sorted, dry. [GWS]
20							11.0 - 15.0' Cobbles and sand Black, abundant cobbles from 11 to 15 feet, sand is fine to coarse grain, dry, very difficult drilling. [GPS]
25							15.0 - 17.0' Sandy gravel Gray, silty, 1 to 3" gravel, very fine grained sand, poor spoon recovery, dry. [GM]
30	0004-130	SS	10,50-5"	0.70	28.0 - 30.0'		17.0 - 20.0' Sandy Gravel Very cobbly, very difficult drilling, dry. [GPS]
35	0004-131	SS	10,50-6"	0.50	30.0 - 32.0'		20.0 - 22.0' Gravelly silty sand Gray, orange brown, fine grain, 25% silt, moderately sorted, 1-3" size gravel, abundant basalt gravel, dry. [SGM]
40	0004-132	SS	9,18,40,37	1.80	32.0 - 34.0'		22.0 - 25.0' Sandy gravel Abundant cobbles, encountered boulder at 25 feet, difficult drilling, drilled adding water. [GWS]
45	0004-133	SS	8,20,21,10	1.70	34.0 - 36.0'		25.0 - 28.0' Sandy gravel Black, gray, 1-3" size gravel, boulder at 25-26'; clayey fine grained sand from 26-27'. [GWS]
50	0004-134	SS	4,8,8,8	1.80	36.0 - 38.0'		28.0 - 30.0' Gravelly silty sand Brown, orange, very fine to fine grain, 15-20% silty, clayey in part, 1-2"
55	0004-135	SS	3,12,50-5"	1.80	38.0 - 40.0'		
60							

Continued Next Page

Sheet 1 of 2

GEOTECH 1054.GPJ HYD-TUC.GDT 1/18/03

ASARCO CONSULTING INC.

Air Sparging Well

Hole Name: SPAR-2

Date Hole Started: 4/28/2000 Date Hole Finished: 4/28/2000

(Continued)

DEPTH	SAMPLE NUMBER	SAMPLE TYPE	BLOW COUNT	RECOVERY (feet)	DRILLING AND GEOTECHNICAL NOTES	GRAPHICS	GEOLOGICAL DESCRIPTION
65							size gravel, moist, driller adding water. [SM]
65							30.0 - 32.0' Sandy silty gravel Brown, black, orange brown, 1-3" size, angular to subrounded gravel, 15% fine to very fine grain sand, 15% silt, moist and green and then silty clay stringers.
70							[GM]
70							32.0 - 34.0' Sand
75							32-33' sand, brown, fine grain, 10% medium grain, moderately sorted, loose, becoming silty, clayey and gravelly at 33-34', silty, gravelly sand at 33-34'.
75							[SPI]
80							34.0 - 36.0' Sand/gravelly clayey sand
80							34-35' sand, brown, fine grained, well sorted, trace silt, loose, grading to gravelly silty clayey sand from 35-36', hole making approx. 1 gpm.
85							[SP]
85							36.0 - 38.0' Sand/gravelly clayey silt
90							36-37' sand, brown, fine to medium grain, moderately sorted, 5% silt, loose, wet. 37-38' gravelly clayey silt, brown, non-plastic, moist, gravelly at 38'.
90							[SPI]
95							38.0 - 40.0' Sand/Silty Gravelly Clay
95							38-39' sand, olive brown, fine to medium grain, moderately sorted, loose, changing to 40% silt to very silty very fine grain and at 39'. From 39.5 to 40' lithology becomes clayey and gravelly.
100							[SM]
100							
105							
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155							

GEOTECH 1054.GPJ HYD-TUC.GDT 1/16/03

ASARCO CONSULTING INC.

Air Sparging Well

Hole Name: SPAR-3

Date Hole Started: 5/18/2000 Date Hole Finished: 5/22/2000

Client: ASARCO, INC.

Project: Interim Measures East Helena Facility

County: Lewis and Clark State: Montana

Property Owner: Asarco Inc.

Legal Description: NW,NW,NE Sec 36 T10N, R3W

Descriptive Location: South of American Chemet

Recorded By: MB/JR

Drilling Company: Hydrometrics, Inc.

Driller: Ron Meinstma

Drilling Method: Air Rotary/ODEX

Drilling Fluids Used: Water (approximately 100 gallons)

Purpose of Hole: Air Sparging Well

Target Aquifer: First Water

Hole Diameter (in): 6

Total Depth Drilled (ft): 40

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	2-inch, flush threaded, Sch 40, PVC	+2.6-37
Surface Casing Used?	Y	5-inch steel	+3 to -2
Screen/Perforations?	Y	0.010-inch slot, Sch 40, PVC	35-37
Sand Pack?	Y	10-20 silica sand	34-40
Annular Seal?	Y	Bentonite Chips/Bentonite Grout	32-34 chips; 1-32 grout
Surface Seal?	Y	Cement	0-1
DEVELOPMENT/SAMPLING			
Well Developed?	Y	pumping	
Water Samples Taken?	Y	common ions, metals	
Boring Samples Taken?	Y	lithologic identification	

Static Water Level Below MP: 33.1

Date: 5/23/00

MP Description: Top of PVC, BELOW T

MP Height Above or Below Ground (ft): 2.64

Surface Casing Height (ft): 2.8

Riser Height (ft): 2.6

Ground Surface Elevation (ft): 3898.04

MP Elevation (ft): 3900.68

Remarks: All soil descriptions and size fraction distributions based on field observations and tests; Depth water encountered: 30.5' Samples collected with 3-inch diameter spoons on 2 7/8-inch rods, driven by a 300 lb/30-inch drop auto hammer.

DEPTH	SAMPLE NUMBER	SAMPLE TYPE	BLOW COUNT	RECOVERY (feet)	DRILLING AND GEOTECHNICAL NOTES	GRAPHICS	GEOLOGICAL DESCRIPTION
5	0005--132	SS	2,3,4,4	2.00	5.0 - 7.0'		0.0 - 5.0' Sand and Gravel brown, fine to coarse grain sand and gravel, unconconsolidated, dry. [SPG]
10	0005--133	SS	20,32,42,34	1.80	10.0 - 12.0'		5.0 - 7.0' Well Graded Sand/Low Plasticity Silt Well graded, fine to coarse, subangular sand with <5% silt/fines; dry, loose; grading to low plasticity silt, soft, slightly moist at 6.3'; gravels present in silt, 30%, subrounded to 1" diameter. [SW]
15	0005--134	SS	25,46,50-6"	1.40	15.0 - 17.0'		10.0 - 12.0' Dark Green Cobbles with Silt Matrix Dark green cobbles, with rust colored iron oxide silt matrix. Silt is low to medium plasticity, 25-30%. Some gravels with cobbles, rounded to subangular, cobbles pitted. [GM]
20	0005--135	SS	20,50-6"	0.90	20.0 - 22.0'		15.0 - 17.0' Pea Gravels with Sand and Silt Fine to coarse, well graded sand with silt and gravels; silt 5-10%, gravels pea to 2"+, gravels well graded; unit slightly moist, dense; gravels subangular to rounded. [GPS]
25	0005--136	SS	15,60-6"	1.00	25.0 - 27.0'		20.0 - 22.0' Dark Green Cobbles in Silty Sand Matrix Dark green cobbles and gravels; pitted, moist to saturated, silty sand matrix has iron oxide color, <20% of sample, silts are 10% of total sample, gravels and cobbles are subrounded to chipped; sand matrix baked on cobbles, very dense. [GPS]
30	0005--137	SS	50-6"	0.50	28.0 - 30.0'		25.0 - 27.0' Dark Green Cobbles in Silty Sand Matrix As above, dark green cobbles with silty sand matrix. [GPS]
35	0005--138	SS	28,32,35,35	1.70	30.0 - 32.0'		28.0 - 30.0' Sandy Gravel with Silt Gravel subrounded to angular and chipped; well graded pea to 1"+ with sand and silt; 35% sand, well graded, fine to coarse, subangular, silt 15%; saturated. [GPS]
40	0005--139	SS	11,24,20,19	1.50	32.0 - 34.0'		30.0 - 32.0' Gravelly Sand Brown, black, orange brown, fine to medium grain, moderately sorted, 10% fine to coarse gravel, trace cobbles, 10% silt, moist; driller adding water. [SPG]
45	0005--140	SS	8,30,60-4"	0.90	34.0 - 36.0'		32.0 - 34.0' Gravelly Silty Sand
50	0005--141	SS	5,5,7,11	1.60	36.0 - 38.0'		
55	0005--142	SS	2,3,9,24	1.70	38.0 - 40.0'		
60							

Continued Next Page

Sheet 1 of 2

GEOTECH 1054.GPJ HYD-TUC.GDT 1/16/03

ASARCO CONSULTING INC.

Air Sparging Well

Hole Name: SPAR-3

Date Hole Started: 5/18/2000 Date Hole Finished: 5/22/2000

(Continued)

DEPTH	SAMPLE NUMBER	SAMPLE TYPE	BLOW COUNT	RECOVERY (feet)	DRILLING AND GEOTECHNICAL NOTES	GRAPHICS	GEOLOGICAL DESCRIPTION
65							Brown, black, orange brown, fine to medium grain, 3% coarse grain, 10-15% silt, 10-15% fine to coarse gravel; wet, borehole making approximately 1/4 gpm. [SPG]
65							34.0 - 36.0' Gravelly Silty Sand
70							As above, brown, fine to medium grain, 15-20% silt, trace clayey, 30-40% fine to coarse gravel, wet. [SPG]
75							36.0 - 38.0' Silty Sand
75							Brown, orange brown, fine to medium grain, moderately to well sorted, 20% silt, becoming clayey from 37-38', 2 inches of brown clay at 37.5', 3% fine pea size gravel, wet. [SM]
80							38.0 - 40.0' Silty Sand/Clayey Silt
85							Brown, orange brown, fine to medium grain, trace coarse grain, moderately sorted, 15% silt, encounter dense clayey silt from 38.5 to 39.5'. [SM]
90							
95							
100							
105							
110							
115							
120							
125							
130							
135							
140							
145							
150							
155							

GEOTECH 1054.GPJ HYD-TUC.GDT 1/18/03

ASARCO CONSULTING INC.

Air Sparging Monitoring Well

Hole Name: STW-1

Date Hole Started: 4/25/2000 Date Hole Finished: 4/26/2000

Client: ASARCO, INC.

Project: Interim Measures East Helena Facility

County: Lewis and Clark State: Montana

Property Owner: Asarco Inc.

Legal Description: NW,NW,NE Sec 36 T10N, R3W

Descriptive Location: South of American Chemet

Recorded By: JR

Drilling Company: Hydrometrics, Inc.

Driller: Ron Meinstma

Drilling Method: Air Rotary/ODEX

Drilling Fluids Used: Water

Purpose of Hole: Air Sparge Monitoring Well

Target Aquifer: First Water

Hole Diameter (in): 6

Total Depth Drilled (ft): 40

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	2-inch, flush threaded, Sch 40, PVC	+2.4-40
Surface Casing Used?	Y	5-inch steel	+3 to -2
Screen/Perforations?	Y	0.010-inch slot, Sch 40, PVC	33-38
Sand Pack?	Y	10-20 silica sand	31-40
Annular Seal?	Y	Bentonite Chips/Bentonite Grout	29-31 chips, 0.5-29 grout
Surface Seal?	Y	Cement	0-0.5

DEVELOPMENT/SAMPLING

Well Developed?	Y	pumping
Water Samples Taken?	Y	common ions, metals
Boring Samples Taken?	Y	lithologic identification

Static Water Level Below MP: 33.76

Date: 5/2/2000

MP Description: Top of PVC

MP Height Above or Below Ground (ft): 2.4

Surface Casing Height (ft): 2.6

Riser Height (ft): 2.4

Ground Surface Elevation (ft): 3899.77

MP Elevation (ft): 3902.17

Remarks: All soil descriptions and size fraction distributions based on field observations and tests; Samples collected with 3-inch diameter spoons on 2 7/8-inch rods, driven by a 300 lb/30-inch drop auto hammer.

DEPTH	SAMPLE NUMBER	SAMPLE TYPE	BLOW COUNT	RECOVERY (feet)	DRILLING AND GEOTECHNICAL NOTES	GRAPHICS	GEOLOGICAL DESCRIPTION
5							0.0 - 0.5' Fill Sand and gravel, unconsolidated, dry. [FILL]
10							0.5 - 4.0' Sand Light brown, gray, fine grain, well sorted, coarse, dry. [SP]
15							5.0 - 10.0' Sandy gravel Light brown, fine to coarse grain, abundant basalt gravel, very cobbly from 7 to 10'. Dry. [GWS]
20							10.0 - 22.0' Sandy gravel As above, abundant cobbles. [GWS]
25							22.0 - 25.0' Sand Brown, fine grain, well sorted, some gravel, dry, large cobble at 23.5'. [SP]
30	0004--113	SS	20,25,35,36	2.00	28.0 - 30.0'		25.0 - 28.0' Sandy gravel Light brown, gray, black, gravel is 1-2" in size. Sand is fine to medium grain, moderately sorted, dry. [GPS]
35	0004--114	SS	22,21,18,23	2.00	30.0 - 32.0'		28.0 - 30.0' Silty gravel Brown, orange, red, black, angular gravel to 3", predominantly fine sand very silty, 20% fine to coarse sand, poorly sorted, trace clay, abundant basalt gravel, weakly cemented, dry. [GM]
40	0004--115	SS	12,29,23,16	2.00	32.0 - 34.0'		30.0 - 32.0' Silty gravel/gravelly silty sand Silty gravel 30-31', gravel 2-4" in size, silty fine sand matrix, damp, weakly cemented, gravelly sand 31-32', orange brown, fine to medium grain, 15-20% silty, trace clayey, medium dense, wet at 32'. [GM]
45	0004--116	SS	10,20,16,15	1.80	34.0 - 36.0'		32.0 - 34.0' Gravelly silty sand Brown, orange brown, fine to medium grain, 5% coarse grain, moderately sorted, silty, 15% silt, medium dense, trace loose, 10-15%, 2-3" size gravel, wet. [SPG]
50	0004--117	SS	7,12,7,11	1.40	36.0 - 38.0'		34.0 - 36.0' Gravelly silty sand
55	0004--118	SS	3,12,18,19	1.00	38.0 - 40.0'		
60							

Continued Next Page

Sheet 1 of 2

GEOTECH 1054.GPJ HYD-TUC.GDT 1/16/03

ASARCO CONSULTING INC.

Air Sparging Monitoring Well

Hole Name: STW-1

Date Hole Started: 4/25/2000 Date Hole Finished: 4/26/2000

(Continued)

DEPTH	SAMPLE NUMBER	SAMPLE TYPE	BLOW COUNT	RECOVERY (feet)	DRILLING AND GEOTECHNICAL NOTES	GRAPHICS	GEOLOGICAL DESCRIPTION
65							Brown, orange brown, red, black, fine to coarse grain, poorly sorted, silty, 15-20% silt, trace clayey, 10% gravel, fine to coarse, up to 3" in size, hole making water 1-2 gpm. [SPG]
65							36.0 - 38.0' Gravelly sand
70							Brown, fine to coarse grain, poorly sorted, silty, 10% silt, trace clayey, medium dense to loose, 5-1% gravel, fine to coarse, wet. [SPG]
70							38.0 - 40.0' Gravelly sand
75							As above, except clayey, brown clay, low plasticity, 5% clay. [SP-SC]
75							
80							
80							
85							
85							
90							
90							
95							
95							
100							
100							
105							
105							
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120							
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135							
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145							
150							
150							
155							
155							

GEOTECH 1054.GPJ HYD-TUC.GDT 1/16/03

ASARCO CONSULTING INC.

Air Sparging Monitoring Well

Hole Name: STW-2

Date Hole Started: 4/24/2000 Date Hole Finished: 4/25/2000

Client: ASARCO, INC.

Project: Interim Measures East Helena Facility

County: Lewis and Clark State: Montana

Property Owner: Asarco Inc.

Legal Description: NW,NW,NE Sec 36 T10N, R3W

Descriptive Location: South of American Chemet

Recorded By: JR

Drilling Company: Hydrometrics, Inc.

Driller: Ron Meinstma

Drilling Method: Air Rotary/ODEX

Drilling Fluids Used: Water (approx. 40 gal)

Purpose of Hole: Air Sparge Monitoring Well

Target Aquifer: First Water

Hole Diameter (in): 6

Total Depth Drilled (ft): 40

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	2-inch, flush threaded, Sch 40, PVC	+2.6-39
Surface Casing Used?	Y	5-inch steel	+3 to -2
Screen/Perforations?	Y	0.020-inch slot, Sch 40 PVC	34-39
Sand Pack?	Y	10-20 silica sand	32-39
Annular Seal?	Y	Chips, bentonite grout	30-32 chips 0-30 bentonite
Surface Seal?	Y	Cement	0-0.5
DEVELOPMENT/SAMPLING			
Well Developed?	Y	pumping	
Water Samples Taken?	Y	common ions, metals	
Boring Samples Taken?	Y	lithologic identification	

Static Water Level Below MP: 33.05

Date: 5/2/2000

MP Description: Top of PVC

MP Height Above or Below Ground (ft): 2.6

Surface Casing Height (ft): 2.8

Riser Height (ft): 2.6

Ground Surface Elevation (ft): 3898.3

MP Elevation (ft): 3900.90

Remarks: All soil descriptions and size fraction distributions based on field observations and tests; Samples collected using 2-inch split spoons and 140 lb hammer.

DEPTH	SAMPLE NUMBER	SAMPLE TYPE	BLOW COUNT	RECOVERY (feet)	DRILLING AND GEOTECHNICAL NOTES	GRAPHICS	GEOLOGICAL DESCRIPTION
5	0004--100	SS	10,42,51	1.40	5.0 - 6.5'		0.0 - 0.5' FILL Fill - coarse rounded gravels (FILL)
10	0004--101	SS	50-2*	0.00	10.0 - 10.1'		0.5 - 5.0' Sand Sand, brown, fine to medium grained, moderately sorted, unconsolidated, dry, clayey in part. (SPI)
15	0004--102	SS	50-6*	0.10	15.0 - 16.5'		5.0 - 6.5' Sandy gravel Brown. Sand as above from 5 to 6.8' grading to gray sandy gravel, sand is fine to medium grained, moderately sorted, gravel 1-2" in size, dry. (GPS)
20	0004--103	SS	21,50-6*	0.60	20.0 - 21.5'		6.5 - 9.0' Gravelly sand Gravelly sand - fine to coarse grain becoming very gravelly or cobbly at 9.0', dry. (SPGI)
25	0004--104	SS	48,28,50-5*	0.30	25.0 - 26.5'		10.0 - 15.0' Sandy gravel No split spoon recovery, drills like coarse gravels or cobbles, very difficult drilling. (GPS)
30	0004--105	SS	12,23,41	1.00	28.0 - 29.5'		15.0 - 20.0' Sandy gravel Difficult drilling, adding water, drilling in sandy gravels and cobbles. (GPS)
35	0004--106	SS	28,50-4*	0.50	29.5 - 31.0'		20.0 - 21.5'
40	0004--107	SS	38,50-6*	1.40	31.0 - 32.5'		20.0 - 21.5' Sandy gravel Gray, trace purple, fine to coarse sand, basalt gravel, some cobbles, poor split spoon recovery. (GPS)
45	0004--108	SS	20,23,22	1.00	32.5 - 34.0'		22.0 - 25.0'
50	0004--109	SS	14,28,50-5*	0.50	34.0 - 35.5'		25.0 - 26.0'
55	0004--110	SS	35,50-5*	0.70	35.5 - 37.0'		25.0 - 26.0' Sandy gravel Poor split spoon recovery, fine to coarse sand, coarse angular basalt gravel, 26-28 sandy gravel. (GPS)
60	0004--111	SS	15,43,50-5*	1.00	37.0 - 38.5'		28.0 - 29.5'
	0004--112	SS	50-6*	0.50	38.5 - 40.0'		28.0 - 29.5' Sand Gray clayey silt at top of spoon, grading to silty sand and gravel - orange brown, mottled, medium to coarse grain, poorly sorted, silty, dense to unconsolidated, trace gravel, 1-1 1/2" in size.

Continued Next Page

Sheet 1 of 2

GEOTECH 1054.GPJ HYD-TUC.GDT 1/18/03

ASARCO CONSULTING INC.

Air Sparging Monitoring Well

Hole Name: STW-2

Date Hole Started: 4/24/2000 Date Hole Finished: 4/25/2000

(Continued)

DEPTH	SAMPLE NUMBER	SAMPLE TYPE	BLOW COUNT	RECOVERY (feet)	DRILLING AND GEOTECHNICAL NOTES	GRAPHICS	GEOLOGICAL DESCRIPTION
65							<p>[SGM] 29.5 - 31.0' Gravelly sand Orange brown, gray mottled, 10-15% silt, fine to coarse grain, poorly sorted, 1-1 1/2" in size, angular gravel. [SPG]</p>
70							<p>31.0 - 32.5' Gravelly sand Orange brown, gray white, fine to medium grain, trace coarse grain, silt, 10% silt, trace clayey, wet, dense to loose, 10% gravel, black, 1-2" in size, thin lense of gray clay. [SPG]</p>
75							<p>32.5 - 34.0' Gravelly/clayey sand Olive brown, trace orange, fine grain, well sorted, clayey, trace thin 1" clay seams, 10-15%, 1 1/2" size gravel. [SGC]</p>
80							<p>34.0 - 35.5' Gravelly/clayey sand Olive brown, as above, fine grain, very clayey, well to moderately sorted, 10% medium grain, 20% 1-2" size angular gravel, predominantly basalt gravel. [SGC]</p>
85							<p>35.5 - 37.0' Sandy gravel Olive brown, 1-2" size angular basalt and quartzite gravel, fine to medium sand, moderately sorted, trace silty and clayey, 15% fines. [GPS]</p>
90							<p>37.0 - 38.5' Clayey/gravelly sand Olive brown, trace orange, fine grain, well sorted, clayey, 10% gravel, dense to slightly dense. [SPG]</p>
95							<p>38.5 - 40.0' Gravelly sand Olive brown, as above, less clayey than above, very fine to fine grain, well sorted, clayey in part. Borehole making water. [SPG]</p>
100							
105							
110							
115							
120							
125							
130							
135							
140							
145							
150							
155							

GEOTECH 1054.GPJ HYD-TUC.GDT 1/16/03

ASARCO CONSULTING INC.

Air Sparging Monitoring Well

Hole Name: STW-3

Date Hole Started: 4/29/2000 Date Hole Finished: 4/29/2000

Client: ASARCO, INC.

Project: Interim Measures East Helena Facility

County: Lewis and Clark State: Montana

Property Owner: Asarco Inc.

Legal Description: NW,NW,NE Sec 36 T10N, R3W

Descriptive Location: South of American Chemet

Recorded By: JR

Drilling Company: Hydrometrics, Inc.

Driller: Ron Meinstma

Drilling Method: Air Rotary/ODEX

Drilling Fluids Used: Water

Purpose of Hole: Air Sparge Monitoring Well

Target Aquifer: First Water

Hole Diameter (in): 6

Total Depth Drilled (ft): 40

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	2-inch, flush threaded, Sch 40, PVC	+2.7-40
Surface Casing Used?	Y	5-inch steel	+3 to -2
Screen/Perforations?	Y	0.010-inch slot, Sch 40, PVC	34.5-39.5
Sand Pack?	Y	10-20 silica sand	33-40
Annular Seal?	Y	Bentonite Pellets/Bentonite Grout	31-33 pellets, 1-31 grout
Surface Seal?	Y	Cement	0-0.5

DEVELOPMENT/SAMPLING

Well Developed?	Y	pumping
Water Samples Taken?	Y	common ions, metals
Boring Samples Taken?	Y	lithologic identification

Static Water Level Below MP: 33.47

Date: 5/2/2000

MP Description: Top of PVC

MP Height Above or Below Ground (ft): 2.7

Surface Casing Height (ft): 2.9

Riser Height (ft): 2.7

Ground Surface Elevation (ft): 3898.73

MP Elevation (ft): 3901.43

Remarks: All soil descriptions and size fraction distributions based on field observations and tests; Samples collected with 3-inch diameter spoons on 2 7/8-inch rods, driven by a 300 lb/30-inch drop auto hammer.

DEPTH	SAMPLE NUMBER	SAMPLE TYPE	BLOW COUNT	RECOVERY (feet)	DRILLING AND GEOTECHNICAL NOTES	GRAPHICS	GEOLOGICAL DESCRIPTION
5							0.0 - 5.0' Silty sand Brown, very fine to fine grain, 35% silt, trace clayey, loose, slightly moist. [SM]
10							5.0 - 10.0' Gravelly sand Brown, tan, fine to coarse grain, poorly sorted, 20% fine to coarse gravel. [SWG]
15							10.0 - 15.0' Sandy gravel Black, brown, fine to coarse gravel, fine to coarse sand, 30% sand, abundant cobbles, 10% silt, driller adding water. [GW-GM]
20							15.0 - 20.0' Sandy gravel As above, abundant large cobbles. [GW-GM]
25							20.0 - 22.0' Sand Brown, fine to medium grain, 10% coarse grain, moderately to poorly sorted. [SP]
30	0004-136	SS	14,50-4*	0.40	28.0 - 30.0'		22.0 - 27.0' Sandy gravel as above, black, brown, fine to coarse gravel, fine to coarse sand, 30% sand, abundant cobbles, 10% silt, driller adding water. [GWS]
35	0004-137	SS	17,35,50-3*	1.00	30.0 - 32.0'		27.0 - 28.0' Silty sand Brown, fine to medium grain, 15% silt, trace clayey, wet, driller adding water. [SM]
40	0004-138	SS	14,28,25,31	1.50	32.0 - 34.0'		28.0 - 30.0' Sandy silty gravel Black, brown, orange, fine to coarse gravel, abundant basalt gravel, 30% fine to medium sand, 10% silt, poor sample recovery. Trace cobbles. [GWS]
45	0004-139	SS	16,23,50-5*	1.00	34.0 - 36.0'		30.0 - 32.0' Sand/sandy gravel Orange brown, fine to medium grain, moderately sorted, loose, wet. Sandy silty gravel at bottom 6" of spoon. [GWS]
50	0004-140	SS	4,6,6,18	2.00	36.0 - 38.0'		32.0 - 34.0' Sandy silty gravel Orange brown, brown, black, fine to coarse gravel, 1-3" in size, 25% fine grain sand, 20% silt, medium dense, wet, trace cobbles. [GPS]
55	0004-141	SS	7,14,25,45	1.80	38.0 - 40.0'		
60							

Continued Next Page

Sheet 1 of 2

GEOTECH 1054.GPJ-HYD-TUC.GDT 1/16/03

ASARCO CONSULTING INC.

Air Sparging Monitoring Well

Hole Name: STW-3

Date Hole Started: 4/29/2000 Date Hole Finished: 4/29/2000

(Continued)

DEPTH	SAMPLE NUMBER	SAMPLE TYPE	BLOW COUNT	RECOVERY (feet)	DRILLING AND GEOTECHNICAL NOTES	GRAPHICS	GEOLOGICAL DESCRIPTION
65							34.0 - 36.0' Gravelly silty sand Orange brown, fine grained, 10% medium to coarse grain, moderately sorted, 30% silt, semi-loose to medium dense, 10% fine to coarse gravel. [SP]
70							36.0 - 38.0' Sandy silt/silty sand 36-37' sandy silt, brown, 25% very fine grain sand, medium dense, wet 37-38' silty sand, very fine to fine grain, 25% silt, non-plastic, wet. [ML]
75							38.0 - 40.0' Sand Brown, fine to medium grain, moderately sorted, 5-10% silt, loose, wet, borehole making water, changes to clayey silty sandy gravel at 39.5'. [SP]
80							
85							
90							
95							
100							
105							
110							
115							
120							
125							
130							
135							
140							
145							
150							
155							

GEOTECH 1054.GPJ HYD-TUC.GDT 1/16/03

ASARCO CONSULTING INC.

Air Sparging Monitoring Well

Hole Name: STW-4

Date Hole Started: 5/2/2000 Date Hole Finished: 5/2/2000

Client: ASARCO, INC.

Project: Interim Measures East Helena Facility

County: Lewis and Clark State: Montana

Property Owner: Asarco Inc.

Legal Description: NW,NW,NE Sec 36 T10N, R3W

Descriptive Location: South of American Chemet

Recorded By: JR

Drilling Company: Hydrometrics, Inc.

Driller: Ron Meinstma

Drilling Method: Air Rotary/ODEX

Drilling Fluids Used: Water

Purpose of Hole: Air Sparge Monitoring Well

Target Aquifer: First Water

Hole Diameter (in): 6

Total Depth Drilled (ft): 40

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	2-inch, flush threaded, Sch 40, PVC	+2.5-37
Surface Casing Used?	Y	5-inch steel	+3 to -2
Screen/Perforations?	Y	0.010-inch slot, Sch 40, PVC	32-37
Sand Pack?	Y	10-20 silica sand	31-40
Annular Seal?	Y	Bentonite Pellets/Bentonite Grout	29-31 pellets, 1-29 grout
Surface Seal?	Y	Cement	0-0.5

DEVELOPMENT/SAMPLING

Well Developed?	Y	pumping
Water Samples Taken?	Y	common ions, metals
Boring Samples Taken?	Y	lithologic identification

Static Water Level Below MP: 32.85

Date: 5/2/2000

MP Description: Top of PVC

MP Height Above or Below Ground (ft): 2.5

Surface Casing Height (ft): 2.7

Riser Height (ft): 2.5

Ground Surface Elevation (ft): 3898.09

MP Elevation (ft): 3900.59

Remarks: All soil descriptions and size fraction distributions based on field observations and tests; Samples collected with 3-inch diameter spoons on 2 7/8-inch rods, driven by a 300 lb/30-inch drop auto hammer.

DEPTH	SAMPLE NUMBER	SAMPLE TYPE	BLOW COUNT	RECOVERY (feet)	DRILLING AND GEOTECHNICAL NOTES	GRAPHICS	GEOLOGICAL DESCRIPTION
5							0.0 - 4.0' Sandy Silt Light brown, medium dense, 25% very fine grain sand, moist. [ML]
10							4.0 - 10.0' Gravelly Sand Brown, black, fine to medium grain, moderately sorted, 40% fine to medium size gravel. [SPG]
15							10.0 - 15.0' Sandy Silty Gravel Brown, black, fine to coarse size gravel, gravel 1-2" in size. 45% fine to medium grain sand, 15% silt; driller adding water. [GPS]
20							15.0 - 20.0' Gravelly Sand Brown, orange brown, fine grained, well sorted, 30% fine to coarse size gravel, occasional cobble. [SPG]
25							20.0 - 28.0' Sandy Silty Gravel Brown, black, as above, boulder from 20.5 to 24'. [GM]
30	0004--154	SS	11,16,20,10	1.70	28.0 - 30.0'		28.0 - 30.0' Sand/Gravelly Sand 28-29' sand, orange brown, fine to medium grain, moderately sorted, semi-loose to loose, becoming mostly fine grained, silty and gravelly from 29-30'. [SP]
35	0004--155	SS	4,8,20,10	1.90	30.0 - 32.0'		30.0 - 32.0' Silty Sandy Gravel Brown, reddish orange, fine to coarse size gravel, subangular to subrounded, 30% very fine grain sand, 25% silt, medium dense to dense, encounter water at 30'. [GM]
40	0004--156	SS	4,28,26,10	2.00	32.0 - 34.0'		32.0 - 34.0' Sand/Silty Sandy Gravel Sand 32-33', brown, fine grain, 10% medium grain, well sorted, loose, changing to silty sandy gravel at 33-34', 20% silt, clayey in part, dense. [SP]
45	0004--157	SS	7,28,36,8	1.90	34.0 - 36.0'		34.0 - 36.0' Gravelly Sand Brown, fine to medium grain, becoming very coarse grain and loose at 35.5', fine to coarse gravel, 10% silt, borehole making lots of water at 35', coarse sand at 35.5-36', moderately well sorted. [SPG]
50	0004--158	SS	6,8,4,10	1.80	36.0 - 38.0'		36.0 - 38.0'
55	0004--159	SS	14,62,38,34	1.70	38.0 - 40.0'		
60							

Continued Next Page

Sheet 1 of 2

GEOTECH 1054.GPJ HYD-TUC.GDT 1/16/03

ASARCO CONSULTING INC.

Air Sparging Monitoring Well

Hole Name: STW-4

Date Hole Started: 5/2/2000 Date Hole Finished: 5/2/2000

(Continued)

DEPTH	SAMPLE NUMBER	SAMPLE TYPE	BLOW COUNT	RECOVERY (feet)	DRILLING AND GEOTECHNICAL NOTES	GRAPHICS	GEOLOGICAL DESCRIPTION
65							Sand/Silt Sand 36-37', brown, medium grain, 10% fine and coarse sand, loose, making water. 37-38' silt, brown, mottled orange, clayey, 15% clay, firm, no plasticity. [SP-SM]
70							38.0 - 40.0' Silty Sandy Gravel Brown, orange brown, coarse gravel 3-4 inches in size, abundant basalt gravel, 30% fine sand, 25% silt, dense, moderately cemented. [GM]
75							
80							
85							
90							
95							
100							
105							
110							
115							
120							
125							
130							
135							
140							
145							
150							
155							

GEOTECH 1054.GPJ HYD-TUC.GDT 1/16/03

ASARCO CONSULTING INC.

Air Sparging Monitoring Well

Hole Name: STW-5

Date Hole Started: 5/1/00 Date Hole Finished: 5/1/00

Client: ASARCO, INC.

Project: Interim Measures East Helena Facility

County: Lewis and Clark State: Montana

Property Owner: Asarco Inc.

Legal Description: NW,NW,NE Sec 36 T10N, R3W

Descriptive Location: South of American Chemet

Recorded By: JR

Drilling Company: Hydrometrics, Inc.

Driller: Ron Meinstra

Drilling Method: Air Rotary/ODEX

Drilling Fluids Used: Water

Purpose of Hole: Air Sparge Monitoring Well

Target Aquifer: First Water

Hole Diameter (in): 6

Total Depth Drilled (ft): 40

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	2-inch, flush threaded, Sch 40, PVC	+2.7-40
Surface Casing Used?	Y	5-inch steel	+3 to -2
Screen/Perforations?	Y	0.010-inch slot, Sch 40, PVC	34-39
Sand Pack?	Y	10-20 silica sand	32.5-40
Annular Seal?	Y	Bentonite Pellets/Bentonite Grout	29-32.5 bentonite pellet,
Surface Seal?	Y	Cement	0-1
DEVELOPMENT/SAMPLING			
Well Developed?	Y	pumping	
Water Samples Taken?	Y	common ions, metals	
Boring Samples Taken?	Y	lithologic identification	

Static Water Level Below MP: 32.70

Date: 5/2/2000

MP Description: Top of PVC

MP Height Above or Below Ground (ft): 2.7

Surface Casing Height (ft): 2.9

Riser Height (ft): 2.7

Ground Surface Elevation (ft): 3897.74

MP Elevation (ft): 3900.44

Remarks: All soil descriptions and size fraction distributions based on field observations and tests; Samples collected with 3-inch diameter spoons on 2 7/8-inch rods, driven by a 300 lb/30-inch drop auto hammer.

DEPTH	SAMPLE NUMBER	SAMPLE TYPE	BLOW COUNT	RECOVERY (feet)	DRILLING AND GEOTECHNICAL NOTES	GRAPHICS	GEOLOGICAL DESCRIPTION
5							0.0 - 5.0' Silt Grey, light brown, moist, medium dense. [ML]
10							5.0 - 15.0' Gravelly Sand with silt Brown, fine grain, 10% medium grain, occasional cobbles, 15% silt, becoming less gravelly from 12-15'. Gravel is fine to medium in size, subangular, subrounded, dry. [SM]
15							15.0 - 20.0' Sandy Gravel Brown, black fine to coarse gravel, occasional cobbles, 35% very fine to fine grain sand, driller adding water. [GWS]
20							20.0 - 25.0' Gravelly Sand Brown, black fine grain sand, occasional cobbles, 40% fine to coarse size gravel, driller adding water. [SP1]
25							25.0 - 28.0' Sandy Gravel Brown, black fine to coarse gravel, occasional cobbles, 30-35% very fine to fine grain sand, driller adding water. [GWS]
30	0004-148	SS	50-6"	0.00	28.0 - 30.0'		28.0 - 30.0' Sandy Silty Gravel No recovery in split spoon, sandy silty gravel with cobbles, driller adding water. [GWS]
35	0004-149	SS	9,16,19,22	1.80	30.0 - 32.0'		30.0 - 32.0' Gravelly Silty Sand Orange brown, fine to medium grain, moderately sorted, 10-15% silt, fine to coarse gravel, gravel to 3+ inches, medium dense, wet. [SPG]
40	0004-150	SS	10,12,11,11	1.90	32.0 - 34.0'		32.0 - 34.0' Gravelly Silty Sand Orange brown, brown, fine to medium grain, 10% silt, no gravel from 33.5 to 34, medium dense, wet. [SPG]
45	0004-151	SS	11,27,16,7	1.80	34.0 - 36.0'		34.0 - 36.0' Sand/Gravelly Silty Sand 34-35' sand, brown, white, fine to coarse grain, poorly sorted, 5% fine to coarse size gravel, 35-36' gravelly, silty sand, fine grain 20% silt, silt from 35.50-36'. [SPG]
50	0004-152	SS	2,4,6,7	1.80	36.0 - 38.0'		
55	0004-153	SS	1,9,18,17	1.90	38.0 - 40.0'		
60							

Continued Next Page

Sheet 1 of 2

GEOTECH 1054.GPJ HYD-TUC.GDT 1/18/03

ASARCO CONSULTING INC.

Air Sparging Monitoring Well

Hole Name: STW-5

Date Hole Started: 5/1/00 Date Hole Finished: 5/1/00

(Continued)

DEPTH	SAMPLE NUMBER	SAMPLE TYPE	BLOW COUNT	RECOVERY (feet)	DRILLING AND GEOTECHNICAL NOTES	GRAPHICS	GEOLOGICAL DESCRIPTION
65							<div> <div>[SP]</div> <div>36.0 - 38.0'</div> <div>Sand</div> <div>36-37 sand, fine to medium grain, moderately to well sorted, loose to semi-loose, making water. 37-38 silt, brown 15% very fine grain sand, medium dense.</div> </div>
70							<div> <div>[SP]</div> <div>38.0 - 40.0'</div> <div>Sand/Silty Sandy Gravel</div> <div>38-39' sand, fine grain, well sorted semi-loose to loose, 5% silt, 39-40 silty sandy gravel.</div> </div>
75							
80							
85							
90							
95							
100							
105							
110							
115							
120							
125							
130							
135							
140							
145							
150							
155							

GEOTECH 1054.GPJ HYD-TUC.GDT 1/18/03

ASARCO CONSULTING INC.

Air Sparging Monitoring Well

Hole Name: STW-6

Date Hole Started: 4/29/2000 Date Hole Finished: 4/30/2000

Client: ASARCO, INC.

Project: Interim Measures East Helena Facility

County: Lewis and Clark State: Montana

Property Owner: Asarco Inc.

Legal Description: NW,NW,NE Sec 36 T10N, R3W

Descriptive Location: South of American Chemet

Recorded By: JR

Drilling Company: Hydrometrics, Inc.

Driller: Ron Meinstra

Drilling Method: Air Rotary/ODEX

Drilling Fluids Used: Water

Purpose of Hole: Air Sparge Monitoring Well

Target Aquifer: First Water

Hole Diameter (in): 6

Total Depth Drilled (ft): 40

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	2-inch, flush threaded, Sch 40, PVC	+2.6-40
Surface Casing Used?	Y	5-inch steel	+3 to -2
Screen/Perforations?	Y	0.010-inch slot, Sch 40, PVC	34-39
Sand Pack?	Y	10-20 silica sand	32.5-40
Annular Seal?	Y	Bentonite Pellets/Bentonite Grout	30-32.5 pellets, 1.0-32 grout
Surface Seal?	Y	Cement	0-1
DEVELOPMENT/SAMPLING			
Well Developed?	Y	pumping	
Water Samples Taken?	Y	common ions, metals	
Boring Samples Taken?	Y	lithologic identification	

Static Water Level Below MP: 33.92

Date: 5/2/2000

MP Description: Top of PVC

MP Height Above or Below Ground (ft): 1.87

Surface Casing Height (ft): 2.8

Riser Height (ft): 2.6

Ground Surface Elevation (ft): 3898.11

MP Elevation (ft): 3899.98

Remarks: All soil descriptions and size fraction distributions based on field observations and tests; Samples collected with 3-inch diameter spoons on 2 7/8-inch rods, driven by a 300 lb/30-inch drop auto hammer.

DEPTH	SAMPLE NUMBER	SAMPLE TYPE	BLOW COUNT	RECOVERY (feet)	DRILLING AND GEOTECHNICAL NOTES	GRAPHICS	GEOLOGICAL DESCRIPTION
5							0.0 - 5.0' Gravelly sand Gray, brown, fine to coarse grain, poorly sorted, 25% fine to medium gravel, 10% silt, dry. [SW-SM]
10							5.0 - 21.0' Sandy silty gravel Brown, black, fine to coarse size gravel, subangular to subrounded, 15% silt, abundant cobbles, dry. [GM]
15							
20							
25							21.0 - 25.0' Basalt boulder Difficult drilling through 4-foot boulder. [GM]
30	0004--142	SS	24,37,40,50-4	1.20	28.0 - 30.0'		25.0 - 28.0' Sandy silty gravel as above, driller adding water. [GM]
35	0004--143	SS	11,28,40,30	1.80	30.0 - 32.0'		28.0 - 30.0' Gravelly sand Sand 28-29'. Brown, fine grain, 10% medium grain, moderately sorted, loose, medium dense changing to very silty, trace clayey from 29-30', 1-3" size gravel. [SP-SM]
40	0004--144	SS	4,8,17,45	1.70	32.0 - 34.0'		30.0 - 32.0' Silty sandy gravel/silty gravelly sand Brown, orange, black, fine to coarse size gravel, fine grain sand, 15% silt from 30-31' changing to silty gravelly sand 31-32', orange brown, brown 30% silt, dense, wet. [GM]
45	0004--145	SS	14,30,31,50-5	1.70	34.0 - 36.0'		32.0 - 34.0' Gravelly sand Brown, fine to medium grain, 15% medium grain, trace coarse grain, 10% fine gravel becoming very silty and trace clayey from 33.5-34.0'. [SP-SM]
50	0004--146	SS	14,40,45,50-5	1.80	36.0 - 38.0'		34.0 - 36.0' Gravelly sand 34-35' brown, orange, fine to medium grain, 10% coarse grain, poorly sorted, 5% silt, semi-loose, becoming more silty (15% silt) and dense from 35-36', fine to coarse gravel, wet.
55	0004--147	SS	8,31,30,15	1.70	38.0 - 40.0'		
60							

Continued Next Page

Sheet 1 of 2

ASARCO CONSULTING INC.

Air Sparging Monitoring Well

Hole Name: STW-6

Date Hole Started: 4/29/2000 Date Hole Finished: 4/30/2000

(Continued)

DEPTH	SAMPLE NUMBER	SAMPLE TYPE	BLOW COUNT	RECOVERY (feet)	DRILLING AND GEOTECHNICAL NOTES	GRAPHICS	GEOLOGICAL DESCRIPTION
65							[SW-SM] 36.0 - 38.0' Gravelly silty sand Brown, fine to medium grain, 10% coarse grain, 15-20% silt, poorly sorted, semi-loose to medium dense, wet.
70							[SM] 38.0 - 40.0' Sand/Gravelly Sand Brown, fine to medium grain, 10-15% coarse grain, semi-loose to medium dense, 5-10% silt, becoming gravelly at 38.5 to 39.5'. Gray and orange brown sandy silt from 39.5 to 40.0'. Little or no groundwater yield at 38'.
75							[SW-SM]
80							
85							
90							
95							
100							
105							
110							
115							
120							
125							
130							
135							
140							
145							
150							
155							

GEOTECH 1054.GPJ HYD-TUC.GDT 1/18/03

ASARCO CONSULTING INC.

Air Sparging Monitoring Well

Hole Name: STW-7

Date Hole Started: 7/16/2001 Date Hole Finished: 7/17/2001

Client: ASARCO, INC.

Project: Interim Measures East Helena Facility

County: Lewis and Clark State: Montana

Property Owner: Asarco, Inc.

Legal Description: NW,NW,NE S 36 T10N, R3W

Descriptive Location: Sparge Area/Bellyard

Recorded By: Melissa Schaar/Mark Brooke

Drilling Company: Hydrometrics, Inc.

Driller: Ron Meinstma

Drilling Method: Air Rotary/ODEX

Drilling Fluids Used: Water

Purpose of Hole: Air Sparge Monitoring Well

Target Aquifer: First Water

Hole Diameter (in): 6

Total Depth Drilled (ft): 40

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	2-inch, flush threaded, Sch 40, PVC	+2.5-40
Surface Casing Used?	Y	5-inch steel	+2.7 to -2.3
Screen/Perforations?	Y	0.020-inch slot, Sch 40 PVC	25-40
Sand Pack?	Y	10-20 silica sand	20-40
Annular Seal?	Y	Bentonite Pellets/Bentonite Grout	17-20 pellets, 1-17 grout
Surface Seal?	Y	Cement	0-1
DEVELOPMENT/SAMPLING			
Well Developed?	Y	pumping	
Water Samples Taken?	Y	common ions, metals	
Boring Samples Taken?	Y	lithologic identification	

Static Water Level Below MP: 30.3

Date: 7/17/2001

MP Description: Top of PVC

MP Height Above or Below Ground (ft): 2.5

Surface Casing Height (ft): 2.7

Riser Height (ft): 2.5

Ground Surface Elevation (ft): 3899.828

MP Elevation (ft): 3902.33

Remarks: All soil descriptions and size fraction distributions based on field observations and tests; Depth water encountered: 28 ft. Used 40 gallons of water.

DEPTH	SAMPLE NUMBER	SAMPLE TYPE	BLOW COUNT	RECOVERY (feet)	DRILLING AND GEOTECHNICAL NOTES	GRAPHICS	GEOLOGICAL DESCRIPTION
5							0.0 - 0.5' Sand and gravel Brown to dark brown, fine to coarse grained sand and gravel; dry. [Fill]
10							0.5 - 5.0' Silty sand Light brown, very fine to fine sand; 35% silt; dry; <10% gravels (pea size). [Alluvium]
15							5.0 - 10.0' Sand and gravel Brown, fine to coarse sand and fine to medium gravels; angular gravels <10% fines. [Alluvium]
20							10.0 - 26.0' Sandy gravels Brown, fine to coarse gravels, angular, well graded; coarse sand. [Alluvium]
25							
30	1	SS	50-5"	0.20	26.0 - 28.0'		26.0 - 28.0' Sandy gravels and cobbles Coarse gravels and cobbles; poor return; fine to coarse sand, 25%; dry. [Alluvium]
35	2	SS	20/36/50-R	1.00	28.0 - 30.0' Duplicate 2D on 7/16/01 at 14:15, blow count: 28/36/50-R, recovery 1.0		28.0 - 30.0' Sand with cobbles Brown, medium to coarse sand; clean; at 29.0 feet; large cobble; wet. [Alluvium]
40	3	SS	27/27/37/50-R	1.30	30.0 - 32.0'		30.0 - 34.0' Sand/gravel/cobbles Brown, medium to coarse sand with fine to coarse gravel lenses approx 1-2 inches thick; large cobble at 31.5 feet; wet. [Alluvium]
45	4	SS	13/34/-R	0.00	32.0 - 34.0'		34.0 - 36.0' Gravelly sand with cobbles Brown, coarse sand; 40% fine to coarse gravels and cobbles, subrounded to angular; 10% silt; wet. [Alluvium]
50	5	SS	13/29/14/18	1.50	34.0 - 36.0'		36.0 - 37.0' Gravelly sand Brown, coarse sand; 40% fine to coarse gravels and cobbles, subrounded to angular; 10% silt; wet. [Alluvium]
55	6	SS	19/41/13/45	2.00	36.0 - 38.0'		37.0 - 38.0' Clayey sand Brown, clayey sand; fine to coarse sand; 35% fines; firm, dense; <10%
60	7	SS	14/50-R	1.50	38.0 - 40.0'		
	8	SS	1/14/7/8	2.00	40.0 - 42.0'		

Continued Next Page

Sheet 1 of 2

GEOTECH 1054.GPJ HYD-TUC.GDT 1/16/03

ASARCO CONSULTING INC.

Air Sparging Monitoring Well

Hole Name: STW-7

Date Hole Started: 7/16/2001 Date Hole Finished: 7/17/2001

(Continued)

DEPTH	SAMPLE NUMBER	SAMPLE TYPE	BLOW COUNT	RECOVERY (feet)	DRILLING AND GEOTECHNICAL NOTES	GRAPHICS	GEOLOGICAL DESCRIPTION
65							gravels; wet. [Alluvium] 38.0 - 40.0'
70							Gravelly sand Brown, coarse sand; medium to coarse gravels and cobbles; areas of higher silt content approx. 35%; wet. [Alluvium] 40.0 - 42.0'
75							Sand Brown, coarse sand; clean; wet; <5% fines. [Alluvium]
80							
85							
90							
95							
100							
105							
110							
115							
120							
125							
130							
135							
140							
145							
150							
155							

GEOTECH 1034.GPJ HYD-TUC.GDT 1/16/03

ASARCO CONSULTING INC.

Air Sparging Monitoring Well

Hole Name: STW-8

Date Hole Started: 7/17/2001 Date Hole Finished: 7/18/2001

Client: ASARCO, INC.

Project: Interim Measures East Helena Facility

County: Lewis and Clark State: Montana

Property Owner: Asarco, Inc.

Legal Description: NW,NW,NE S 36 T10N, R3W

Descriptive Location: Sparge Area/Bellyard

Recorded By: Melissa Schaar/Mark Brooke

Drilling Company: Hydrometrics, Inc.

Driller: Ron Meintsma

Drilling Method: Air Rotary/ODEX

Drilling Fluids Used: Water

Purpose of Hole: Air Sparge Monitoring Well

Target Aquifer: First Water

Hole Diameter (in): 6

Total Depth Drilled (ft): 40

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	2-inch, flush threaded, Sch 40, PVC	+2.6-40
Surface Casing Used?	Y	5-inch steel	+2.8 to -2.2
Screen/Perforations?	Y	0.020-inch slot, Sch 40 PVC	35-40
Sand Pack?	Y	10-20 silica sand	33-40
Annular Seal?	Y	Bentonite Pellets/Bentonite Grout	28-33 pellets, 1-28 grout
Surface Seal?	Y	Cement	0-1
DEVELOPMENT/SAMPLING			
Well Developed?	Y	pumping	
Water Samples Taken?	Y	common ions, metals	
Boring Samples Taken?	Y	lithologic identification	

Static Water Level Below MP: 29.8

Date: 7/18/2001

MP Description: Top of PVC

MP Height Above or Below Ground (ft): 2.6

Surface Casing Height (ft): 2.8

Riser Height (ft): 2.6

Ground Surface Elevation (ft): 3899.534

MP Elevation (ft): 3902.13

Remarks: All soil descriptions and size fraction distributions based on field observations and tests; Depth water encountered: 28 ft.

Note at 38' Sparge I (10 ft. downgradient of STW-8) started to blow water above the riser pipe.

DEPTH	SAMPLE NUMBER	SAMPLE TYPE	BLOW COUNT	RECOVERY (feet)	DRILLING AND GEOTECHNICAL NOTES	GRAPHICS	GEOLOGICAL DESCRIPTION
5							0.0 - 0.5' Sand and gravel Fine to coarse sand and gravels; well rounded to subangular; dry; <5% fines. [Fill]
10							0.5 - 7.0' Silty sandy gravels Light brown, fine to coarse gravels; fine to coarse sand, approx. 25%; 15% silt; dry. Adding minor amounts of water. [Alluvium]
15							7.0 - 8.0' Sand Reddish brown, fine to coarse, well graded; <10% gravels; dry; very little fines. [Alluvium]
20							8.0 - 10.0' Gravels/cobbles Fine to coarse gravels and cobbles; <20% fine to coarse sand; <5% fines. [Alluvium]
25	1	SS	13/50 per 3"	0.40	26.0 - 28.0'		10.0 - 26.0' Sandy gravels and cobbles Brown, fine to coarse gravels with large cobbles; fine to coarse sand, approx. 25%; varying degrees of fines ranging from no fines to approx. 10% fines; dry. [Alluvium]
30	2	SS	21/50 per 0"	0.50	28.0 - 30.0'		26.0 - 28.0' Sandy gravels and cobbles Brown, fine to coarse gravels and cobbles; approx. 50% cobbles; fine to coarse sand; 5% fines; dry. [Alluvium]
35	3	SS	28/50-R	0.50	30.0 - 32.0'		28.0 - 30.0' Silty gravels and cobbles Brown, fine to coarse gravels and cobbles; 15% silt; 5-10% fine to coarse sand; wet. [Alluvium]
40	4	SS	12/50-R	0.30	32.0 - 34.0'		30.0 - 32.0' Silty sand/gravels and cobbles Brown, fine to coarse gravels and cobbles; 15% fine to coarse sand; 10% silt; wet. [Alluvium]
45	5	SS	9/50-R	0.10	34.0 - 36.0'		32.0 - 36.0' Sand and cobbles Brown, coarse sand; intermittent cobbles; 10% silt; 5% gravels; wet. [Alluvium]
50	6	SS	50-R	0.30	36.0 - 38.0'		36.0 - 42.0' Silty sand with cobbles
55	7	SS	19/50-R	0.30	38.0 - 40.0'		
60	8	SS	20/50-R	0.20	40.0 - 42.0'		

Continued Next Page

Sheet 1 of 2

GEOTECH 1054.GPJ HYD-TUC.GDT 1/18/03

ASARCO CONSULTING INC.

Air Sparging Monitoring Well

Hole Name: STW-8

Date Hole Started: 7/17/2001 Date Hole Finished: 7/18/2001

(Continued)

DEPTH	SAMPLE NUMBER	SAMPLE TYPE	BLOW COUNT	RECOVERY (feet)	DRILLING AND GEOTECHNICAL NOTES	GRAPHICS	GEOLOGICAL DESCRIPTION
65							Brown, fine to coarse sand; 15% silt; large cobbles; wet. [Alluvium]
70							
75							
80							
85							
90							
95							
100							
105							
110							
115							
120							
125							
130							
135							
140							
145							
150							
155							

GEOTECH 1084.GPJ HYD-TUC.GDT 1/18/03

ASARCO CONSULTING INC.

Air Sparging Monitoring Well

Hole Name: STW-9

Date Hole Started: 7/18/2001 Date Hole Finished: 7/19/2001

Client: ASARCO, INC.

Project: Interim Measures East Helena Facility

County: Lewis and Clark State: Montana

Property Owner: Asarco, Inc.

Legal Description: NW,NW,NE S 36 T10N, R3W

Descriptive Location: Sparge Area/Bellyard

Recorded By: Melissa Schaar/Mark Brooke

Drilling Company: Hydrometrics, Inc.

Driller: Ron Meintsma

Drilling Method: Air Rotary/ODEX

Drilling Fluids Used: Water

Purpose of Hole: Air Sparge Monitoring Well

Target Aquifer: First Water

Hole Diameter (in): 6

Total Depth Drilled (ft): 40

WELL COMPLETION	Y/N	DESCRIPTION	INTERVAL
Well Installed?	Y	2-inch, flush threaded, Sch 40, PVC	+2.5-40
Surface Casing Used?	Y	5-inch steel	+2.7 to -3.3
Screen/Perforations?	Y	0.020-inch slot, Sch 40 PVC	35-40
Sand Pack?	Y	10-20 silica sand	32.5-40
Annular Seal?	Y	Bentonite Pellets/Bentonite Grout	25.5-32.5 pellets, 1-25.5 grout
Surface Seal?	Y	Cement	0-1
DEVELOPMENT/SAMPLING			
Well Developed?	Y	pumping	
Water Samples Taken?	Y	common ions, metals	
Boring Samples Taken?	Y	lithologic identification	

Static Water Level Below MP: 29.25

Date: 7/19/2001

MP Description: Top of PVC

MP Height Above or Below Ground (ft): 2.5

Surface Casing Height (ft): 2.7

Riser Height (ft): 2.5

Ground Surface Elevation (ft): 3898.399

MP Elevation (ft): 3900.90

Remarks: All soil descriptions and size fraction distributions based on field observations and tests; Depth water encountered: 28'; Used 70 gallons of water.

DEPTH	SAMPLE NUMBER	SAMPLE TYPE	BLOW COUNT	RECOVERY (feet)	DRILLING AND GEOTECHNICAL NOTES	GRAPHICS	GEOLOGICAL DESCRIPTION
0.0 - 0.5'							Sand and gravel Brown, fine to coarse sand and gravel; no fines; dry. [Fill]
0.5 - 5.0'							Sandy silt Light brown silt, fine to medium sand, approx. 35-45%; varying to silty sand; dry; <5% gravels. [Alluvium]
5.0 - 10.0'							Gravelly sand Orange brown, fine to coarse sand; well graded; fine to medium gravels approx. 40%; <5% fines; dry. [Alluvium]
10.0 - 26.0'							Sandy gravel and cobbles/boulders Brown, fine to coarse gravels with cobbles and boulders; fine to coarse sand approx. 20%; <5% fines; increasing fines with depth; dry; large boulder at 12 feet. [Alluvium]
26.0 - 28.0'	1	SS	50 for 6"	0.10	26.0 - 28.0'		Sandy silt and cobbles Brown, fine to medium sand, approx. 30%; large cobbles; dry. [Alluvium]
28.0 - 30.0'	2	SS	8/4/21/44	1.80	28.0 - 30.0'		28.0 - 30.0'
30.0 - 32.0'	3	SS	50 for 5"	0.10	30.0 - 32.0'		Sandy silt Brown/orange, very fine sand; wet; mica flakes; weathered cobbles (intermed igneous). [Alluvium]
32.0 - 34.0'	4	SS	13/50 for 3"	0.10	32.0 - 34.0'		30.0 - 32.0'
34.0 - 36.0'	5	SS	22/48/50	1.00	34.0 - 36.0'		Sandy silt/cobbles Brown silt, fine sand; very wet; large cobbles. [Alluvium]
36.0 - 38.0'	6	SS	4/31/50-R	1.50	36.0 - 38.0'		32.0 - 34.0'
38.0 - 40.0'	7	SS	30/R	0.20	38.0 - 40.0'		Silty sand/gravel/cobbles Brown, silty sand, coarse grained; with gravels and cobbles; difficult to determine grading percentages due to poor return. [Alluvium]
40.0 - 42.0'	8	SS	22/R		40.0 - 42.0'		34.0 - 36.0'
							Silty sand/gravel/cobbles Brown/white silt, fine to coarse sand; silty chunks resembling volcanic ash; fine to coarse gravels and cobbles; cobbles are partially weathered intermediate igneous rocks; wet. [Alluvium]
							36.0 - 38.0'
							Sandy silt with weathered cobbles

Continued Next Page

Sheet 1 of 2

GEOTECH 1054.GPJ HYD-TUC.GDT 1/18/03

ASARCO CONSULTING INC.

Air Sparging Monitoring Well

Hole Name: STW-9

Date Hole Started: 7/18/2001 Date Hole Finished: 7/19/2001

(Continued)

DEPTH	SAMPLE NUMBER	SAMPLE TYPE	BLOW COUNT	RECOVERY (feet)	DRILLING AND GEOTECHNICAL NOTES	GRAPHICS	GEOLOGICAL DESCRIPTION
65							Brown/gray/orange; very fine sand; angular pieces (gravel size) of feldspars; weathered igneous cobbles; wet. [Alluvium] 38.0 - 40.0'
70							Silty sand/gravels/cobbles Brown silty sand/gravels/cobbles; difficult to determine proportion due to poor return; making at least 5 gpm. [Alluvium] 40.0 - 42.0'
75							No return; cobbles?
80							
85							
90							
95							
100							
105							
110							
115							
120							
125							
130							
135							
140							
145							
150							
155							

GEOTECH 1054.GPJ HYD-TUC.GDT 1/18/03

APPENDIX B

IRON SPECIATION DR2000 SUMMARY

SUMMARY OF PROCEDURE USED FOR FIELD MEASUREMENT OF IRON (II) IN WATER SAMPLES

This describes the method used to analyze ferrous iron in groundwater samples in the field. Ferrous iron was determined in the field to obtain results representative of the water being sampled.

EQUIPMENT

- HACH DR 2000 Spectrophotometer
- Iron Standard
- Distilled Water
- Acid rinsed polyethylene bottles (100 to 250 ml)
- 0.45 micron filter apparatus with inert filter (for dissolved determinations)

PROCEDURE

The analytical procedure entailed colorimetric iron speciation measurements using the HACH DR 2000 Spectrophotometer. The analyses were performed in the field using the following procedures:

- Groundwater samples were collected according to procedures described in the work plan. If the sample was turbid, water was filtered prior to analysis through a 0.45 μ m filter, so that the turbidity would not interfere with the colorimetric measurement.
- If the sample concentration was estimated to be greater than 3 mg/L, the sample was diluted using clean volumetric glassware and deionized water so that iron concentration was less than 3 mg/L.
- A blank vial and sample beaker were filled with the sample to be analyzed. The tip was broken of a vacuum-sealed glass ampule of ferrous iron reagent (supplied by HACH Company) while the tip was submerged in sample water, such that the sample was aspirated into the ampule. The timer was then started on the DR2000 spectrophotometer for ferrous iron analysis (3-minute reaction time). An orange-red color developed in the sample in proportion to the iron concentration.
- After the 3-minute reaction time, the spectrophotometer was zeroed using the blank vial, then the concentration was measured in the reagent ampule. The DR2000 measures absorbance and converts the reading directly to mg/L using an internal calibration curve.

Iron speciation measurements in groundwater samples (concentrations of Fe^{2+} and Fe^{3+}) will be collected using a field-portable HACH DR2000 spectrophotometer. Ferrous iron (Fe^{2+}) and total iron ($\text{Fe}(\text{tot})$) are measured independently, and Fe^{3+} is calculated as the difference between total and ferrous iron, or $[\text{Fe}(\text{tot}) - \text{Fe}^{2+}]$. The analytical procedure for colorimetric iron speciation measurements is detailed in the DR2000 Methods Manual, and is summarized below:

1. Collect groundwater sample. If sample is turbid, filtration may be required so that turbidity does not interfere with the colorimetric measurement.
2. If sample concentration is estimated to be greater than 3 mg/L, dilute sample using clean volumetric glassware and deionized water so that iron concentration is less than 3 mg/L.
3. Fill blank vial and sample beaker with sample to be analyzed for total or ferrous iron. Break the tip from a vacuum-sealed glass ampule of total or ferrous iron reagent (supplied by HACH Company) while the tip is submerged in sample water, such that the sample is aspirated into the ampule. Start the timer on the DR2000 spectrophotometer for either total or ferrous iron analysis (3-minute reaction time). An orange-red color will develop in the sample in proportion to the iron concentration.
4. After the 3-minute reaction time, zero the spectrophotometer using the blank vial, then measure the concentration in the reagent ampule. The DR2000 measures absorbance and converts the reading directly to mg/L using an internal calibration curve.
5. Duplicate samples may be run to estimate precision. A standard iron solution (i.e., 1 mg/L) may be run as a sample to estimate accuracy.

APPENDIX C

ANALYTICAL DATA

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Table of Contents by Station Type

<u>Page</u>	<u>Station Type</u>	<u>Station Name</u>
1	Groundwater	DH-24
14	Groundwater	DH-50
26	Groundwater	SPARGE 1
26	Groundwater	SPARGE 2
27	Groundwater	SPARGE 3
33	Groundwater	STW-1
41	Groundwater	STW-2
52	Groundwater	STW-3
63	Groundwater	STW-4
72	Groundwater	STW-5
81	Groundwater	STW-6
88	Groundwater	STW-7
97	Groundwater	STW-8
109	Groundwater	STW-9

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

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East Helena Sparge Project

ANALYSES SUMMARY REPORT

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ASARCO, East Helena Plant

Table of Contents By Lab Sample ID

<u>Page</u>	<u>Lab Sample ID</u>	<u>Sample ID</u>	<u>Sample Date</u>	<u>Station Name</u>
107	0211-219	EHC-0211-219	11/13/2002	STW-8
26	0306-226	AEH-0306-226	6/2/2003	SPARGE 1
26	0306-227	AEH-0306-227	6/2/2003	SPARGE 2
52	0306-228	AEH-0306-228	6/2/2003	STW-2
62	0306-229	AEH-0306-229	6/2/2003	STW-3
80	0306-230	AEH-0306-230	6/2/2003	STW-5
87	0306-231	AEH-0306-231	6/2/2003	STW-6
59	205103	EHST-0205-103A	5/10/2002	STW-3
49	205106	EHST-0205-106	5/10/2002	STW-2
86	205107	EHST-0205-107	5/10/2002	STW-6
113	205108	EHST-0205-108	5/10/2002	STW-9
39	205110	EHST-0205-110	5/10/2002	STW-1
23	205111	EHST-0205-111	5/10/2002	DH-50
39	206109	EHST-0206-109	6/6/2002	STW-1
31	206110	EHST-0206-110	6/6/2002	SPARGE 3
40	207102	EHST-0207-102	7/17/2002	STW-1
40	207305	EHST-0207-305	7/24/2002	STW-1
40	209611	EHST-0209-611	9/26/2002	STW-1
26	AEH-0310-459	AEH-0310-459	10/30/2003	SPARGE 1
26	AEH-0310-460	AEH-0310-460	10/30/2003	SPARGE 2
52	AEH-0310-461	AEH-0310-461	10/30/2003	STW-2
62	AEH-0310-462	AEH-0310-462	10/30/2003	STW-3
80	AEH-0310-463	AEH-0310-463	10/30/2003	STW-5
87	AEH-0310-464	AEH-0310-464	10/30/2003	STW-6
26	AEH-0405-241	AEH-0405-241	5/13/2004	SPARGE 1
27	AEH-0405-242	AEH-0405-242	5/13/2004	SPARGE 2
62	AEH-0405-243	AEH-0405-243	5/13/2004	STW-3
87	AEH-0405-244	AEH-0405-244	5/13/2004	STW-6
80	AEH-0405-245	AEH-0405-245	5/13/2004	STW-5
52	AEH-0405-246	AEH-0405-246	5/13/2004	STW-2
107	EHST-0212-103	EHST-0212-103	12/17/2002	STW-8
62	EHST-0212-104	EHST-0212-104	12/17/2002	STW-3
71	EHST-0212-105	EHST-0212-105	12/17/2002	STW-4
6	FIELD ONLY	EHST-0110-109	10/19/2001	DH-24
6	FIELD ONLY	EHST-0111-110	11/2/2001	DH-24
21	FIELD ONLY	EHST-0111-111	11/2/2001	DH-50
21	FIELD ONLY	EHST-0110-110	10/19/2001	DH-50
30	FIELD ONLY	EHST-0110-100	10/19/2001	SPARGE 3
30	FIELD ONLY	EHST-0111-100	11/2/2001	SPARGE 3
38	FIELD ONLY	EHST-0111-101	11/2/2001	STW-1
45	FIELD ONLY	EHST-0111-102	11/2/2001	STW-2
45	FIELD ONLY	EHST-0110-101	10/19/2001	STW-2

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East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Table of Contents By Lab Sample ID

<u>Page</u>	<u>Lab Sample ID</u>	<u>Sample ID</u>	<u>Sample Date</u>	<u>Station Name</u>
46	FIELD ONLY	EHST-0112-250	12/12/2001	STW-2
55	FIELD ONLY	EHST-0110-102	10/19/2001	STW-3
56	FIELD ONLY	EHST-0112-251	12/12/2001	STW-3
56	FIELD ONLY	EHST-0111-103	11/2/2001	STW-3
66	FIELD ONLY	EHST-0110-103	10/19/2001	STW-4
66	FIELD ONLY	EHST-0111-104	11/2/2001	STW-4
76	FIELD ONLY	EHST-0111-105	11/2/2001	STW-5
76	FIELD ONLY	EHST-0110-104	10/19/2001	STW-5
84	FIELD ONLY	EHST-0111-106	11/2/2001	STW-6
84	FIELD ONLY	EHST-0110-105	10/19/2001	STW-6
88	FIELD ONLY	EHST-0111-107	11/2/2001	STW-7
88	FIELD ONLY	EHST-0110-106	10/19/2001	STW-7
89	FIELD ONLY	EHST-0112-252	12/12/2001	STW-7
99	FIELD ONLY	EHST-0110-107	10/19/2001	STW-8
99	FIELD ONLY	EHST-0111-108	11/2/2001	STW-8
100	FIELD ONLY	EHST-0112-253	12/12/2001	STW-8
109	FIELD ONLY	EHST-0110-108	10/19/2001	STW-9
109	FIELD ONLY	EHST-0111-109	11/2/2001	STW-9
110	FIELD ONLY	EHST-0112-254	12/12/2001	STW-9
24	H04050133-002	AEH-0405-125	5/20/2004	DH-50
72	H04050133-003	AEH-0405-126	5/20/2004	STW-4
114	H04050133-004	AEH-0405-127	5/20/2004	STW-9
114	H04050133-005	AEH-0405-128	5/20/2004	STW-9
107	H04050133-006	AEH-0405-129	5/20/2004	STW-8
97	H04050133-007	AEH-0405-130	5/20/2004	STW-7
41	H04050133-008	AEH-0405-131	5/20/2004	STW-1
33	H04050133-011	AEH-0405-134	5/20/2004	SPARGE 3
14	H04050133-012	AEH-0405-135	5/20/2004	DH-24
13	L021034-001	EHST-0212-100	12/17/2002	DH-24
32	L021034-002	EHST-0212-101	12/17/2002	SPARGE 3
96	L021034-003	EHST-0212-102	12/17/2002	STW-7
13	L030016-001	EHST-0212-100	1/14/2003	DH-24
96	L030016-002	EHST-0212-101	1/14/2003	STW-7
107	L030016-003	EHST-0212-102	1/14/2003	STW-8
14	L000630001	IMMW-0004-120	4/25/2000	DH-50
1	L000703007	EHC-0005-126	5/1/2000	DH-24
1	L000704005	EHC-0005-162	5/1/2000	DH-24
33	L000720001	EHST-0005-100	5/10/2000	STW-1
52	L000720002	EHST-0005-101	5/10/2000	STW-3
81	L000720003	EHST-0005-102	5/10/2000	STW-6
72	L000720004	EHST-0005-103	5/10/2000	STW-5
63	L000720005	EHST-0005-104	5/10/2000	STW-4

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Run Time: 12/10/2004 9:36:30 AM

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Table of Contents By Lab Sample ID

<u>Page</u>	<u>Lab Sample ID</u>	<u>Sample ID</u>	<u>Sample Date</u>	<u>Station Name</u>
41	L000720006	EHST-0005-105	5/10/2000	STW-2
33	L000759001	EHST-0005-110	5/18/2000	STW-1
72	L000759002	EHST-0005-111	5/18/2000	STW-5
63	L000759003	EHST-0005-112	5/18/2000	STW-4
41	L000759004	EHST-0005-113	5/18/2000	STW-2
53	L000759005	EHST-0005-114	5/18/2000	STW-3
81	L000759006	EHST-0005-115	5/18/2000	STW-6
14	L000759008	EHST-0005-117	5/18/2000	DH-50
14	L000759009	EHST-0005-118	5/18/2000	DH-50
16	L000825001	EHST-0005-120	5/30/2000	DH-50
63	L000825002	EHST-0005-121	5/30/2000	STW-4
72	L000825003	EHST-0005-122	5/30/2000	STW-5
81	L000825004	EHST-0005-123	5/30/2000	STW-6
53	L000825005	EHST-0005-124	5/30/2000	STW-3
41	L000825006	EHST-0005-125	5/30/2000	STW-2
33	L000825007	EHST-0005-126	5/30/2000	STW-1
35	L000825008	EHST-0005-127	5/30/2000	STW-1
27	L000825010	EHST-0005-129	5/30/2000	SPARGE 3
16	L000882001	EHST-0006-100	6/6/2000	DH-50
74	L000882002	EHST-0006-101	6/6/2000	STW-5
63	L000882003	EHST-0006-102	6/6/2000	STW-4
43	L000882004	EHST-0006-103	6/6/2000	STW-2
81	L000882005	EHST-0006-104	6/6/2000	STW-6
81	L000882006	EHST-0006-105	6/6/2000	STW-6
53	L000882007	EHST-0006-106	6/6/2000	STW-3
35	L000882009	EHST-0006-108	6/6/2000	STW-1
63	L000910000	EHST-0006-205	6/13/2000	STW-4
16	L000910001	EHST-0006-200	6/13/2000	DH-50
74	L000910002	EHST-0006-201	6/13/2000	STW-5
81	L000910003	EHST-0006-202	6/13/2000	STW-6
53	L000910004	EHST-0006-203	6/13/2000	STW-3
43	L000910005	EHST-0006-204	6/13/2000	STW-2
63	L000910007	EHST-0006-206	6/13/2000	STW-4
35	L000910008	EHST-0006-207	6/13/2000	STW-1
16	L000964003	EHST-0006-302	6/21/2000	DH-50
74	L000964004	EHST-0006-303	6/21/2000	STW-5
82	L000964005	EHST-0006-304	6/21/2000	STW-6
53	L000964006	EHST-0006-305	6/21/2000	STW-3
43	L000964007	EHST-0006-306	6/21/2000	STW-2
64	L000964008	EHST-0006-307	6/21/2000	STW-4
35	L000964009	EHST-0006-308	6/21/2000	STW-1
1	L000964011	EHST-0006-310	6/21/2000	DH-24

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Run Time: 12/10/2004 9:36:30 AM

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroData\DB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Table of Contents By Lab Sample ID

<u>Page</u>	<u>Lab Sample ID</u>	<u>Sample ID</u>	<u>Sample Date</u>	<u>Station Name</u>
16	L001003001	EHST-0006-400	6/29/2000	DH-50
74	L001003002	EHST-0006-401	6/29/2000	STW-5
82	L001003003	EHST-0006-402	6/29/2000	STW-6
53	L001003004	EHST-0006-403	6/29/2000	STW-3
43	L001003005	EHST-0006-404	6/29/2000	STW-2
64	L001003006	EHST-0006-405	6/29/2000	STW-4
35	L001003008	EHST-0006-407	6/29/2000	STW-1
35	L001003009	EHST-0006-408	6/29/2000	STW-1
16	L001116001	EHST-0007-100	7/13/2000	DH-50
74	L001116002	EHST-0007-101	7/13/2000	STW-5
82	L001116003	EHST-0007-102	7/13/2000	STW-6
54	L001116004	EHST-0007-103	7/13/2000	STW-3
43	L001116005	EHST-0007-104	7/13/2000	STW-2
64	L001116006	EHST-0007-105	7/13/2000	STW-4
64	L001116007	EHST-0007-106	7/13/2000	STW-4
36	L001116009	EHST-0007-108	7/13/2000	STW-1
17	L001190001	EHST-0007-200	7/24/2000	DH-50
74	L001190002	EHST-0007-201	7/24/2000	STW-5
64	L001190003	EHST-0007-202	7/24/2000	STW-4
43	L001190004	EHST-0007-203	7/24/2000	STW-2
54	L001190005	EHST-0007-204	7/24/2000	STW-3
54	L001190006	EHST-0007-205	7/24/2000	STW-3
82	L001190007	EHST-0007-206	7/24/2000	STW-6
36	L001190009	EHST-0007-208	7/24/2000	STW-1
17	L001239002	EHST-0008-101	8/3/2000	DH-50
75	L001239003	EHST-0008-102	8/3/2000	STW-5
82	L001239004	EHST-0008-103	8/3/2000	STW-6
54	L001239005	EHST-0008-104	8/3/2000	STW-3
44	L001239006	EHST-0008-105	8/3/2000	STW-2
65	L001239007	EHST-0008-106	8/3/2000	STW-4
36	L001239009	EHST-0008-108	8/3/2000	STW-1
27	L001239010	EHST-0008-109	8/3/2000	SPARGE 3
27	L001239011	EHST-0008-110	8/3/2000	SPARGE 3
1	L001239012	EHST-0008-111	8/3/2000	DH-24
17	L001333002	EHST-0008-201	8/16/2000	DH-50
75	L001333003	EHST-0008-202	8/16/2000	STW-5
82	L001333004	EHST-0008-203	8/16/2000	STW-6
54	L001333005	EHST-0008-204	8/16/2000	STW-3
44	L001333006	EHST-0008-205	8/16/2000	STW-2
65	L001333007	EHST-0008-206	8/16/2000	STW-4
36	L001333009	EHST-0008-208	8/16/2000	STW-1
27	L001333010	EHST-0008-209	8/16/2000	SPARGE 3

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East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Table of Contents By Lab Sample ID

<u>Page</u>	<u>Lab Sample ID</u>	<u>Sample ID</u>	<u>Sample Date</u>	<u>Station Name</u>
1	L001333011	EHST-0008-210	8/16/2000	DH-24
1	L001333012	EHST-0008-211	8/16/2000	DH-24
17	L001441002	EHST-0008-301	8/31/2000	DH-50
65	L001441003	EHST-0008-302	8/31/2000	STW-4
75	L001441004	EHST-0008-303	8/31/2000	STW-5
83	L001441005	EHST-0008-304	8/31/2000	STW-6
54	L001441006	EHST-0008-305	8/31/2000	STW-3
44	L001441007	EHST-0008-306	8/31/2000	STW-2
36	L001441008	EHST-0008-307	8/31/2000	STW-1
28	L001441010	EHST-0008-309	8/31/2000	SPARGE 3
3	L001441011	EHST-0008-310	8/31/2000	DH-24
3	L001441012	EHST-0008-311	8/31/2000	DH-24
17	L001513002	EHST-0009-101	9/13/2000	DH-50
75	L001513003	EHST-0009-102	9/13/2000	STW-5
83	L001513004	EHST-0009-103	9/13/2000	STW-6
55	L001513005	EHST-0009-104	9/13/2000	STW-3
44	L001513006	EHST-0009-105	9/13/2000	STW-2
44	L001513007	EHST-0009-106	9/13/2000	STW-2
65	L001513008	EHST-0009-107	9/13/2000	STW-4
36	L001513010	EHST-0009-109	9/13/2000	STW-1
28	L001513011	EHST-0009-110	9/13/2000	SPARGE 3
3	L001513012	EHST-0009-111	9/13/2000	DH-24
3	L001585003	EHST-0009-202	9/22/2000	DH-24
3	L001585004	EHST-0009-203	9/22/2000	DH-24
28	L001585006	EHST-0009-205	9/22/2000	SPARGE 3
17	L001649002	EHST-0010-101	10/3/2000	DH-50
65	L001649003	EHST-0010-102	10/3/2000	STW-4
44	L001649004	EHST-0010-103	10/3/2000	STW-2
55	L001649005	EHST-0010-104	10/3/2000	STW-3
83	L001649006	EHST-0010-105	10/3/2000	STW-6
75	L001649007	EHST-0010-106	10/3/2000	STW-5
37	L001649008	EHST-0010-107	10/3/2000	STW-1
3	L001649009	EHST-0010-108	10/3/2000	DH-24
4	L001649010	EHST-0010-109	10/3/2000	DH-24
28	L001649012	EHST-0010-111	10/3/2000	SPARGE 3
28	L001753003	EHST-0010-202	10/17/2000	SPARGE 3
4	L001753005	EHST-0010-204	10/17/2000	DH-24
4	L001753006	EHST-0010-205	10/17/2000	DH-24
18	L001861003	EHST-0011-102	11/3/2000	DH-50
65	L001861004	EHST-0011-103	11/3/2000	STW-4
37	L001861005	EHST-0011-104	11/3/2000	STW-1
28	L001861006	EHST-0011-105	11/3/2000	SPARGE 3

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Run Time: 12/10/2004 9:36:30 AM

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Table of Contents By Lab Sample ID

<u>Page</u>	<u>Lab Sample ID</u>	<u>Sample ID</u>	<u>Sample Date</u>	<u>Station Name</u>
29	L001861007	EHST-0011-106	11/3/2000	SPARGE 3
4	L001861009	EHST-0011-108	11/3/2000	DH-24
4	L001873001	EHC-0011-127	11/8/2000	DH-24
18	L001922019	IMMW-0011-120	11/15/2000	DH-50
37	L002044002	EHST-0012-101	12/20/2000	STW-1
18	L002044003	EHST-0012-102	12/20/2000	DH-50
66	L002044004	EHST-0012-103	12/20/2000	STW-4
75	L002044005	EHST-0012-104	12/20/2000	STW-5
45	L002044007	EHST-0012-106	12/20/2000	STW-2
83	L002044008	EHST-0012-107	12/20/2000	STW-6
55	L002044009	EHST-0012-108	12/20/2000	STW-3
29	L002044010	EHST-0012-109	12/20/2000	SPARGE 3
29	L002044011	EHST-0012-110	12/20/2000	SPARGE 3
4	L002044012	EHST-0012-111	12/20/2000	DH-24
29	L010183003	EHST-0102-102	2/7/2001	SPARGE 3
6	L010183004	EHST-0102-103	2/7/2001	DH-24
18	L010183005	EHST-0102-104	2/7/2001	DH-50
18	L010183006	EHST-0102-105	2/7/2001	DH-50
66	L010183007	EHST-0102-106	2/7/2001	STW-4
76	L010183008	EHST-0102-107	2/7/2001	STW-5
37	L010183009	EHST-0102-108	2/7/2001	STW-1
18	L010608017	EHC-0105-155	5/1/2001	DH-50
6	L010691022	EHC-0105-127	5/10/2001	DH-24
45	L010699003	EHC-0105-197	5/14/2001	STW-2
37	L010699006	EHC-0105-196	5/14/2001	STW-1
76	L010699009	EHC-0105-200	5/14/2001	STW-5
29	L010699010	EHC-0105-195	5/14/2001	SPARGE 3
66	L010699012	EHC-0105-199	5/14/2001	STW-4
55	L010699013	EHC-0105-198	5/14/2001	STW-3
83	L010699014	EHC-0105-201	5/14/2001	STW-6
45	L010699015	EHC-0105-232	5/14/2001	STW-2
88	L011184001	EHC-0108-100	8/10/2001	STW-7
97	L011184002	EHC-0108-101	8/10/2001	STW-8
109	L011184003	EHC-0108-102	8/10/2001	STW-9
21	L011367001	EHST-0109-100	9/26/2001	DH-50
66	L011367002	EHST-0109-101	9/26/2001	STW-4
76	L011367003	EHST-0109-102	9/26/2001	STW-5
83	L011367004	EHST-0109-103	9/26/2001	STW-6
55	L011367005	EHST-0109-104	9/26/2001	STW-3
45	L011367006	EHST-0109-105	9/26/2001	STW-2
109	L011367007	EHST-0109-106	9/26/2001	STW-9
97	L011367008	EHST-0109-107	9/26/2001	STW-8

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

Run Time: 12/10/2004 9:36:30 AM

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Table of Contents By Lab Sample ID

<u>Page</u>	<u>Lab Sample ID</u>	<u>Sample ID</u>	<u>Sample Date</u>	<u>Station Name</u>
88	L011367009	EHST-0109-108	9/26/2001	STW-7
37	L011367010	EHST-0109-109	9/26/2001	STW-1
29	L011367011	EHST-0109-110	9/26/2001	SPARGE 3
6	L011367012	EHST-0109-111	9/26/2001	DH-24
6	L011367013	EHST-0109-112	9/26/2001	DH-24
21	L011535018	EHC-0111-153	11/8/2001	DH-50
9	L011563018	EHC-0111-126	11/9/2001	DH-24
30	L011587001	EHST-0111-200	11/20/2001	SPARGE 3
9	L011587002	EHST-0111-201	11/20/2001	DH-24
21	L011587003	EHST-0111-202	11/20/2001	DH-50
67	L011587004	EHST-0111-203	11/20/2001	STW-4
99	L011587005	EHST-0111-204	11/20/2001	STW-8
76	L011587006	EHST-0111-205	11/20/2001	STW-5
84	L011587007	EHST-0111-206	11/20/2001	STW-6
88	L011587008	EHST-0111-207	11/20/2001	STW-7
56	L011587009	EHST-0111-208	11/20/2001	STW-3
46	L011587010	EHST-0111-209	11/20/2001	STW-2
38	L011587011	EHST-0111-210	11/20/2001	STW-1
109	L011587012	EHST-0111-211	11/20/2001	STW-9
46	L011606001	EHST-0111-300	11/30/2001	STW-2
56	L011606002	EHST-0111-301	11/30/2001	STW-3
88	L011606003	EHST-0111-302	11/30/2001	STW-7
99	L011606004	EHST-0111-303	11/30/2001	STW-8
109	L011606005	EHST-0111-304	11/30/2001	STW-9
46	L011614001	EHST-0112-100	12/4/2001	STW-2
56	L011614002	EHST-0112-101	12/4/2001	STW-3
89	L011614003	EHST-0112-102	12/4/2001	STW-7
99	L011614004	EHST-0112-103	12/4/2001	STW-8
110	L011614005	EHST-0112-104	12/4/2001	STW-9
9	L011626001	EHST-0112-200	12/7/2001	DH-24
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21	L011626003	EHST-0112-202	12/7/2001	DH-50
67	L011626004	EHST-0112-203	12/7/2001	STW-4
77	L011626005	EHST-0112-204	12/7/2001	STW-5
84	L011626006	EHST-0112-205	12/7/2001	STW-6
46	L011626007	EHST-0112-206	12/7/2001	STW-2
110	L011626008	EHST-0112-207	12/7/2001	STW-9
56	L011626009	EHST-0112-208	12/7/2001	STW-3
99	L011626010	EHST-0112-209	12/7/2001	STW-8
89	L011626011	EHST-0112-210	12/7/2001	STW-7
38	L011626012	EHST-0112-211	12/7/2001	STW-1
22	L011652001	EHST-0112-300	12/14/2001	DH-50

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Run Time: 12/10/2004 9:36:30 AM

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Table of Contents By Lab Sample ID

<u>Page</u>	<u>Lab Sample ID</u>	<u>Sample ID</u>	<u>Sample Date</u>	<u>Station Name</u>
67	L011652002	EHST-0112-301	12/14/2001	STW-4
77	L011652003	EHST-0112-302	12/14/2001	STW-5
84	L011652004	EHST-0112-303	12/14/2001	STW-6
46	L011652005	EHST-0112-304	12/14/2001	STW-2
110	L011652006	EHST-0112-305	12/14/2001	STW-9
57	L011652007	EHST-0112-306	12/14/2001	STW-3
100	L011652008	EHST-0112-307	12/14/2001	STW-8
89	L011652009	EHST-0112-308	12/14/2001	STW-7
9	L011661001	EHST-0112-400	12/19/2001	DH-24
30	L011661002	EHST-0112-401	12/19/2001	SPARGE 3
22	L011661003	EHST-0112-402	12/19/2001	DH-50
67	L011661004	EHST-0112-403	12/19/2001	STW-4
110	L011661005	EHST-0112-404	12/19/2001	STW-9
47	L011661006	EHST-0112-405	12/19/2001	STW-2
77	L011661007	EHST-0112-406	12/19/2001	STW-5
84	L011661008	EHST-0112-407	12/19/2001	STW-6
57	L011661009	EHST-0112-408	12/19/2001	STW-3
100	L011661010	EHST-0112-409	12/19/2001	STW-8
89	L011661011	EHST-0112-410	12/19/2001	STW-7
38	L011661012	EHST-0112-411	12/19/2001	STW-1
22	L011677001	EHST-0112-500	12/27/2001	DH-50
67	L011677002	EHST-0112-501	12/27/2001	STW-4
77	L011677003	EHST-0112-502	12/27/2001	STW-5
85	L011677004	EHST-0112-503	12/27/2001	STW-6
47	L011677005	EHST-0112-504	12/27/2001	STW-2
110	L011677006	EHST-0112-505	12/27/2001	STW-9
57	L011677007	EHST-0112-506	12/27/2001	STW-3
100	L011677008	EHST-0112-507	12/27/2001	STW-8
89	L011677009	EHST-0112-508	12/27/2001	STW-7
30	L020024001	EHST-0201-109	1/10/2002	SPARGE 3
9	L020024002	EHST-0201-110	1/10/2002	DH-24
22	L020024003	EHST-0201-111	1/11/2002	DH-50
38	L020025001	EHST-0201-100	1/10/2002	STW-1
90	L020025002	EHST-0201-101	1/10/2002	STW-7
100	L020025003	EHST-0201-102	1/10/2002	STW-8
67	L020025004	EHST-0201-103	1/10/2002	STW-4
77	L020025005	EHST-0201-104	1/10/2002	STW-5
47	L020025006	EHST-0201-105	1/10/2002	STW-2
111	L020025007	EHST-0201-106	1/10/2002	STW-9
57	L020025008	EHST-0201-107	1/10/2002	STW-3
85	L020025009	EHST-0201-108	1/10/2002	STW-6
22	L020027001	EHST-0201-200	1/16/2002	DH-50

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

Run Time: 12/10/2004 9:36:30 AM

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Table of Contents By Lab Sample ID

<u>Page</u>	<u>Lab Sample ID</u>	<u>Sample ID</u>	<u>Sample Date</u>	<u>Station Name</u>
100	L020027002	EHST-0201-201	1/16/2002	STW-8
90	L020027003	EHST-0201-202	1/16/2002	STW-7
68	L020027004	EHST-0201-203	1/16/2002	STW-4
77	L020027005	EHST-0201-204	1/16/2002	STW-5
111	L020027006	EHST-0201-205	1/16/2002	STW-9
47	L020027007	EHST-0201-206	1/16/2002	STW-2
57	L020027008	EHST-0201-207	1/16/2002	STW-3
85	L020027009	EHST-0201-208	1/16/2002	STW-6
85	L020027010	EHST-0201-209	1/16/2002	STW-6
38	L020042001	EHST-0201-300	1/23/2002	STW-1
90	L020042002	EHST-0201-301	1/23/2002	STW-7
101	L020042003	EHST-0201-302	1/23/2002	STW-8
68	L020042004	EHST-0201-303	1/23/2002	STW-4
78	L020042005	EHST-0201-304	1/23/2002	STW-5
85	L020042006	EHST-0201-305	1/23/2002	STW-6
57	L020042007	EHST-0201-306	1/23/2002	STW-3
111	L020042008	EHST-0201-307	1/23/2002	STW-9
47	L020042009	EHST-0201-308	1/23/2002	STW-2
22	L020042010	EHST-0201-309	1/23/2002	DH-50
31	L020042011	EHST-0201-310	1/23/2002	SPARGE 3
9	L020042012	EHST-0201-311	1/23/2002	DH-24
11	L020042013	EHST-0201-312	1/23/2002	DH-24
11	L020075001	EHST-0202-400	2/5/2002	DH-24
31	L020075002	EHST-0202-401	2/5/2002	SPARGE 3
23	L020075003	EHST-0202-402	2/5/2002	DH-50
68	L020075004	EHST-0202-403	2/5/2002	STW-4
78	L020075005	EHST-0202-404	2/5/2002	STW-5
85	L020075006	EHST-0202-405	2/5/2002	STW-6
58	L020075007	EHST-0202-406	2/5/2002	STW-3
111	L020075008	EHST-0202-407	2/5/2002	STW-9
47	L020075009	EHST-0202-408	2/5/2002	STW-2
90	L020075010	EHST-0202-409	2/5/2002	STW-7
90	L020075011	EHST-0202-410	2/5/2002	STW-7
101	L020075012	EHST-0202-411	2/5/2002	STW-8
39	L020075013	EHST-0202-412	2/5/2002	STW-1
90	L020096001	EHST-0202-500	2/12/2002	STW-7
101	L020096002	EHST-0202-501	2/12/2002	STW-8
48	L020096003	EHST-0202-502	2/12/2002	STW-2
111	L020096004	EHST-0202-503	2/12/2002	STW-9
58	L020096005	EHST-0202-504	2/12/2002	STW-3
48	L020096006	EHST-0202-600	2/13/2002	STW-2
111	L020096007	EHST-0202-601	2/13/2002	STW-9

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

Run Time: 12/10/2004 9:36:30 AM

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Table of Contents By Lab Sample ID

<u>Page</u>	<u>Lab Sample ID</u>	<u>Sample ID</u>	<u>Sample Date</u>	<u>Station Name</u>
58	L020096008	EHST-0202-602	2/13/2002	STW-3
101	L020096009	EHST-0202-603	2/13/2002	STW-8
91	L020096010	EHST-0202-604	2/13/2002	STW-7
112	L020101001	EHST-0202-700	2/14/2002	STW-9
48	L020101002	EHST-0202-701	2/14/2002	STW-2
58	L020101003	EHST-0202-702	2/14/2002	STW-3
101	L020101004	EHST-0202-703	2/14/2002	STW-8
91	L020101005	EHST-0202-704	2/14/2002	STW-7
112	L020101006	EHST-0202-800	2/15/2002	STW-9
48	L020101007	EHST-0202-801	2/15/2002	STW-2
58	L020101008	EHST-0202-802	2/15/2002	STW-3
101	L020101009	EHST-0202-803	2/15/2002	STW-8
91	L020101010	EHST-0202-804	2/15/2002	STW-7
11	L020110001	EHST-0202-900	2/19/2002	DH-24
31	L020110002	EHST-0202-901	2/19/2002	SPARGE 3
23	L020110003	EHST-0202-902	2/19/2002	DH-50
112	L020110004	EHST-0202-903	2/19/2002	STW-9
48	L020110005	EHST-0202-904	2/19/2002	STW-2
58	L020110006	EHST-0202-905	2/19/2002	STW-3
86	L020110007	EHST-0202-906	2/19/2002	STW-6
78	L020110008	EHST-0202-907	2/19/2002	STW-5
68	L020110009	EHST-0202-908	2/19/2002	STW-4
102	L020110010	EHST-0202-909	2/19/2002	STW-8
102	L020110011	EHST-0202-910	2/19/2002	STW-8
91	L020110012	EHST-0202-911	2/19/2002	STW-7
39	L020110013	EHST-0202-912	2/19/2002	STW-1
91	L020118001	EHST-0202-100	2/22/2002	STW-7
102	L020118002	EHST-0202-101	2/22/2002	STW-8
78	L020118003	EHST-0202-102	2/22/2002	STW-5
112	L020118004	EHST-0202-103	2/22/2002	STW-9
48	L020118005	EHST-0202-104	2/22/2002	STW-2
59	L020118006	EHST-0202-105	2/22/2002	STW-3
39	L020142001	EHST-0202-200	2/27/2002	STW-1
102	L020142002	EHST-0202-201	2/27/2002	STW-8
91	L020142003	EHST-0202-202	2/27/2002	STW-7
23	L020142004	EHST-0202-203	2/27/2002	DH-50
68	L020142005	EHST-0202-204	2/27/2002	STW-4
78	L020142006	EHST-0202-205	2/27/2002	STW-5
86	L020142007	EHST-0202-206	2/27/2002	STW-6
59	L020142008	EHST-0202-207	2/27/2002	STW-3
112	L020142009	EHST-0202-208	2/27/2002	STW-9
49	L020142010	EHST-0202-209	2/27/2002	STW-2

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

Run Time: 12/10/2004 9:36:30 AM

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Table of Contents By Lab Sample ID

<u>Page</u>	<u>Lab Sample ID</u>	<u>Sample ID</u>	<u>Sample Date</u>	<u>Station Name</u>
11	L020278001	EHST-0204-100	4/19/2002	DH-24
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49	L020278004	EHST-0204-103	4/19/2002	STW-2
78	L020278005	EHST-0204-104	4/19/2002	STW-5
68	L020278006	EHST-0204-105	4/19/2002	STW-4
86	L020278007	EHST-0204-106	4/19/2002	STW-6
59	L020278008	EHST-0204-107	4/19/2002	STW-3
102	L020278009	EHST-0204-108	4/19/2002	STW-8
92	L020278010	EHST-0204-109	4/19/2002	STW-7
39	L020278011	EHST-0204-110	4/19/2002	STW-1
11	L020364001	EHST-0205-100	5/10/2002	DH-24
31	L020364002	EHST-0205-101	5/10/2002	SPARGE 3
79	L020364003	EHST-0205-102	5/10/2002	STW-5
69	L020364004	EHST-0205-103	5/10/2002	STW-4
102	L020364005	EHST-0205-104	5/10/2002	STW-8
92	L020364006	EHST-0205-105	5/10/2002	STW-7
23	L020398002	EHC-0205-158	5/30/2002	DH-50
11	L020412029	EHC-0205-131	6/1/2002	DH-24
12	L020426001	EHST-0206-100	6/6/2002	DH-24
69	L020426002	EHST-0206-101	6/6/2002	STW-4
49	L020426003	EHST-0206-102	6/6/2002	STW-2
79	L020426004	EHST-0206-103	6/6/2002	STW-5
113	L020426005	EHST-0206-104	6/6/2002	STW-9
86	L020426006	EHST-0206-105	6/6/2002	STW-6
59	L020426007	EHST-0206-106	6/6/2002	STW-3
103	L020426008	EHST-0206-107	6/6/2002	STW-8
92	L020426009	EHST-0206-108	6/6/2002	STW-7
103	L020591001	EHST-0207-100	7/17/2002	STW-8
92	L020591002	EHST-0207-101	7/17/2002	STW-7
59	L020591003	EHST-0207-103	7/17/2002	STW-3
69	L020591004	EHST-0207-104	7/17/2002	STW-4
49	L020591005	EHST-0207-105	7/17/2002	STW-2
92	L020591006	EHST-0207-200	7/19/2002	STW-7
103	L020591007	EHST-0207-201	7/19/2002	STW-8
92	L020594001	EHST-0207-300	7/24/2002	STW-7
103	L020594002	EHST-0207-301	7/24/2002	STW-8
49	L020594003	EHST-0207-302	7/24/2002	STW-2
69	L020594004	EHST-0207-303	7/24/2002	STW-4
60	L020594005	EHST-0207-304	7/24/2002	STW-3
103	L020594006	EHST-0207-400	7/25/2002	STW-8
93	L020594007	EHST-0207-401	7/25/2002	STW-7

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

Run Time: 12/10/2004 9:36:30 AM

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Table of Contents By Lab Sample ID

<u>Page</u>	<u>Lab Sample ID</u>	<u>Sample ID</u>	<u>Sample Date</u>	<u>Station Name</u>
93	L020606001	EHST-0207-500	7/31/2002	STW-7
103	L020606002	EHST-0207-501	7/31/2002	STW-8
60	L020606003	EHST-0207-502	7/31/2002	STW-3
50	L020606004	EHST-0207-503	7/31/2002	STW-2
69	L020606005	EHST-0207-504	7/31/2002	STW-4
93	L020606006	EHST-0207-600	8/1/2002	STW-7
104	L020606007	EHST-0207-601	8/1/2002	STW-8
12	L020638001	EHST-0208-100	8/8/2002	DH-24
32	L020638002	EHST-0208-101	8/8/2002	SPARGE 3
40	L020638003	EHST-0208-102	8/8/2002	STW-1
104	L020638004	EHST-0208-103	8/8/2002	STW-8
93	L020638005	EHST-0208-104	8/8/2002	STW-7
113	L020638006	EHST-0208-105	8/8/2002	STW-9
50	L020638007	EHST-0208-106	8/8/2002	STW-2
79	L020638008	EHST-0208-107	8/8/2002	STW-5
69	L020642001	EHST-0208-108	8/8/2002	STW-4
23	L020642002	EHST-0208-109	8/8/2002	DH-50
60	L020642003	EHST-0208-110	8/8/2002	STW-3
86	L020642004	EHST-0208-111	8/8/2002	STW-6
104	L020642005	EHST-0208-200	8/9/2002	STW-8
93	L020642006	EHST-0208-201	8/9/2002	STW-7
93	L020650001	EHST-0208-300	8/14/2002	STW-7
104	L020650002	EHST-0208-301	8/14/2002	STW-8
60	L020650003	EHST-0208-302	8/14/2002	STW-3
50	L020650004	EHST-0208-303	8/14/2002	STW-2
70	L020650005	EHST-0208-304	8/14/2002	STW-4
94	L020650006	EHST-0208-400	8/15/2002	STW-7
104	L020650007	EHST-0208-401	8/15/2002	STW-8
79	L020685001	EHST-0208-107RR	8/8/2002	STW-5
94	L020686001	EHST-0208-500	8/22/2002	STW-7
104	L020686002	EHST-0208-501	8/22/2002	STW-8
60	L020686003	EHST-0208-503	8/22/2002	STW-3
70	L020686004	EHST-0208-504	8/22/2002	STW-4
50	L020686005	EHST-0208-502	8/22/2002	STW-2
94	L020705001	EHST-0208-600	8/28/2002	STW-7
105	L020705002	EHST-0208-601	8/28/2002	STW-8
50	L020705003	EHST-0208-602	8/28/2002	STW-2
60	L020705004	EHST-0208-603	8/28/2002	STW-3
70	L020705005	EHST-0208-604	8/28/2002	STW-4
94	L020731001	EHST-0209-100	9/4/2002	STW-7
105	L020731002	EHST-0209-101	9/4/2002	STW-8
50	L020731003	EHST-0209-102	9/4/2002	STW-2

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

Run Time: 12/10/2004 9:36:30 AM

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Table of Contents By Lab Sample ID

<u>Page</u>	<u>Lab Sample ID</u>	<u>Sample ID</u>	<u>Sample Date</u>	<u>Station Name</u>
61	L020731004	EHST-0209-103	9/5/2002	STW-3
70	L020731005	EHST-0209-104	9/4/2002	STW-4
94	L020749001	EHST-0209-200	9/6/2002	STW-7
105	L020749002	EHST-0209-201	9/6/2002	STW-8
12	L020775001	EHST-0209-300	9/12/2002	DH-24
94	L020775002	EHST-0209-301	9/12/2002	STW-7
105	L020775003	EHST-0209-302	9/12/2002	STW-8
95	L020785001	EHST-0209-400	9/19/2002	STW-7
105	L020785002	EHST-0209-401	9/19/2002	STW-8
70	L020785003	EHST-0209-402	9/19/2002	STW-4
51	L020785004	EHST-0209-403	9/19/2002	STW-2
61	L020785005	EHST-0209-404	9/19/2002	STW-3
95	L020785006	EHST-0209-500	9/20/2002	STW-7
105	L020785007	EHST-0209-501	9/20/2002	STW-8
12	L020829001	EHST-0209-600	9/26/2002	DH-24
32	L020829002	EHST-0209-601	9/26/2002	SPARGE 3
24	L020829003	EHST-0209-602	9/26/2002	DH-50
87	L020829004	EHST-0209-603	9/26/2002	STW-6
61	L020829005	EHST-0209-604	9/26/2002	STW-3
79	L020829006	EHST-0209-605	9/26/2002	STW-5
113	L020829007	EHST-0209-606	9/26/2002	STW-9
51	L020829008	EHST-0209-607	9/26/2002	STW-2
12	L020829009	EHST-0209-600A	9/26/2002	DH-24
79	L020829010	EHST-0209-608	9/26/2002	STW-5
106	L020829011	EHST-0209-609	9/26/2002	STW-8
95	L020829012	EHST-0209-610	9/26/2002	STW-7
70	L020845001	EHST-0210-100	10/4/2002	STW-4
51	L020845002	EHST-0210-101	10/4/2002	STW-2
61	L020845003	EHST-0210-104	10/4/2002	STW-3
106	L020845004	EHST-0210-102	10/4/2002	STW-8
95	L020845005	EHST-0210-103	10/4/2002	STW-7
95	L020845006	EHST-0210-200	10/5/2002	STW-7
106	L020845007	EHST-0210-201	10/5/2002	STW-8
71	L020869001	EHST-0210-300	10/17/2002	STW-4
51	L020869002	EHST-0210-301	10/17/2002	STW-2
61	L020869003	EHST-0210-302	9/17/2002	STW-3
106	L020869004	EHST-0210-303	10/17/2002	STW-8
95	L020869005	EHST-0210-304	10/17/2002	STW-7
71	L020888001	EHST-0210-400	10/23/2002	STW-4
51	L020888002	EHST-0210-401	10/23/2002	STW-2
61	L020888003	EHST-0210-402	10/23/2002	STW-3
106	L020888004	EHST-0210-403	10/23/2002	STW-8

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Run Time: 12/10/2004 9:36:30 AM

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Table of Contents By Lab Sample ID

<u>Page</u>	<u>Lab Sample ID</u>	<u>Sample ID</u>	<u>Sample Date</u>	<u>Station Name</u>
96	L020888005	EHST-0210-404	10/23/2002	STW-7
71	L020915001	EHST-0210-500	10/31/2002	STW-4
51	L020915002	EHST-0210-501	10/31/2002	STW-2
62	L020915003	EHST-0210-502	10/31/2002	STW-3
106	L020915004	EHST-0210-503	10/31/2002	STW-8
96	L020915005	EHST-0210-504	10/31/2002	STW-7
71	L020943001	EHC-0211-215	11/13/2002	STW-4
80	L020943002	EHC-0211-216	11/13/2002	STW-5
87	L020943003	EHC-0211-217	11/13/2002	STW-6
62	L020943004	EHC-0211-214	11/13/2002	STW-3
113	L020943005	EHC-0211-220	11/13/2002	STW-9
52	L020943006	EHC-0211-213	11/13/2002	STW-2
96	L020943007	EHC-0211-218	11/13/2002	STW-7
24	L020943008	EHC-0211-156	11/13/2002	DH-50
40	L020943009	EHC-0211-212	11/13/2002	STW-1
32	L020943010	EHC-0211-211	11/13/2002	SPARGE 3
80	L020943013	EHC-0211-239A	11/13/2002	STW-5
12	L020959007	EHC-0211-128	11/18/2002	DH-24
13	L020959008	EHC-0211-250	11/18/2002	DH-24
13	L021034001	EHST-0212-100	12/17/2002	DH-24
32	L021034002	EHST-0212-101	12/17/2002	SPARGE 3
96	L021034003	EHST-0212-102	12/17/2002	STW-7
24	L030245002	AEH-0306-164	6/2/2003	DH-50
113	L030245003	AEH-0306-165	6/2/2003	STW-9
107	L030245004	AEH-0306-166	6/2/2003	STW-8
97	L030245005	AEH-0306-167	6/2/2003	STW-7
71	L030245006	AEH-0306-168	6/2/2003	STW-4
40	L030245007	AEH-0306-169	6/2/2003	STW-1
32	L030245009	AEH-0306-171	6/2/2003	SPARGE 3
13	L030245010	AEH-0306-172	6/2/2003	DH-24
13	L030245011	AEH-0306-173	6/2/2003	DH-24
14	L030605004	AEH-0310-425	10/29/2003	DH-24
24	L030605008	AEH-0310-430	10/29/2003	DH-50
33	L030605013	AEH-0310-436	10/30/2003	SPARGE 3
97	L030605014	AEH-0310-437	10/30/2003	STW-7
41	L030605015	AEH-0310-438	10/30/2003	STW-1
107	L030605016	AEH-0310-439	10/30/2003	STW-8
114	L030605017	AEH-0310-440	10/30/2003	STW-9
114	L030605018	AEH-0310-441	10/30/2003	STW-9
72	L030605019	AEH-0310-442	10/30/2003	STW-4
64	P000343	EHST-0006-307	6/21/2000	STW-4

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

Run Time: 12/10/2004 9:36:30 AM

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Table of Contents by Sample ID

<u>Page</u>	<u>Sample ID</u>	<u>Lab Sample ID</u>	<u>Sample Date</u>	<u>Station Name</u>
24	AEH-0306-164	L030245002	6/2/2003	DH-50
113	AEH-0306-165	L030245003	6/2/2003	STW-9
107	AEH-0306-166	L030245004	6/2/2003	STW-8
97	AEH-0306-167	L030245005	6/2/2003	STW-7
71	AEH-0306-168	L030245006	6/2/2003	STW-4
40	AEH-0306-169	L030245007	6/2/2003	STW-1
32	AEH-0306-171	L030245009	6/2/2003	SPARGE 3
13	AEH-0306-172	L030245010	6/2/2003	DH-24
13	AEH-0306-173	L030245011	6/2/2003	DH-24
26	AEH-0306-226	0306-226	6/2/2003	SPARGE 1
26	AEH-0306-227	0306-227	6/2/2003	SPARGE 2
52	AEH-0306-228	0306-228	6/2/2003	STW-2
62	AEH-0306-229	0306-229	6/2/2003	STW-3
80	AEH-0306-230	0306-230	6/2/2003	STW-5
87	AEH-0306-231	0306-231	6/2/2003	STW-6
14	AEH-0310-425	L030605004	10/29/2003	DH-24
24	AEH-0310-430	L030605008	10/29/2003	DH-50
33	AEH-0310-436	L030605013	10/30/2003	SPARGE 3
97	AEH-0310-437	L030605014	10/30/2003	STW-7
41	AEH-0310-438	L030605015	10/30/2003	STW-1
107	AEH-0310-439	L030605016	10/30/2003	STW-8
114	AEH-0310-440	L030605017	10/30/2003	STW-9
114	AEH-0310-441	L030605018	10/30/2003	STW-9
72	AEH-0310-442	L030605019	10/30/2003	STW-4
26	AEH-0310-459	AEH-0310-459	10/30/2003	SPARGE 1
26	AEH-0310-460	AEH-0310-460	10/30/2003	SPARGE 2
52	AEH-0310-461	AEH-0310-461	10/30/2003	STW-2
62	AEH-0310-462	AEH-0310-462	10/30/2003	STW-3
80	AEH-0310-463	AEH-0310-463	10/30/2003	STW-5
87	AEH-0310-464	AEH-0310-464	10/30/2003	STW-6
24	AEH-0405-125	H04050133-002	5/20/2004	DH-50
72	AEH-0405-126	H04050133-003	5/20/2004	STW-4
114	AEH-0405-127	H04050133-004	5/20/2004	STW-9
114	AEH-0405-128	H04050133-005	5/20/2004	STW-9
107	AEH-0405-129	H04050133-006	5/20/2004	STW-8
97	AEH-0405-130	H04050133-007	5/20/2004	STW-7
41	AEH-0405-131	H04050133-008	5/20/2004	STW-1
33	AEH-0405-134	H04050133-011	5/20/2004	SPARGE 3
14	AEH-0405-135	H04050133-012	5/20/2004	DH-24
26	AEH-0405-241	AEH-0405-241	5/13/2004	SPARGE 1
27	AEH-0405-242	AEH-0405-242	5/13/2004	SPARGE 2
62	AEH-0405-243	AEH-0405-243	5/13/2004	STW-3

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

Run Time: 12/10/2004 9:36:30 AM

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Table of Contents by Sample ID

<u>Page</u>	<u>Sample ID</u>	<u>Lab Sample ID</u>	<u>Sample Date</u>	<u>Station Name</u>
87	AEH-0405-244	AEH-0405-244	5/13/2004	STW-6
80	AEH-0405-245	AEH-0405-245	5/13/2004	STW-5
52	AEH-0405-246	AEH-0405-246	5/13/2004	STW-2
1	EHC-0005-126	L000703007	5/1/2000	DH-24
1	EHC-0005-162	L000704005	5/1/2000	DH-24
4	EHC-0011-127	L001873001	11/8/2000	DH-24
6	EHC-0105-127	L010691022	5/10/2001	DH-24
18	EHC-0105-155	L010608017	5/1/2001	DH-50
29	EHC-0105-195	L010699010	5/14/2001	SPARGE 3
37	EHC-0105-196	L010699006	5/14/2001	STW-1
45	EHC-0105-197	L010699003	5/14/2001	STW-2
55	EHC-0105-198	L010699013	5/14/2001	STW-3
66	EHC-0105-199	L010699012	5/14/2001	STW-4
76	EHC-0105-200	L010699009	5/14/2001	STW-5
83	EHC-0105-201	L010699014	5/14/2001	STW-6
45	EHC-0105-232	L010699015	5/14/2001	STW-2
88	EHC-0108-100	L011184001	8/10/2001	STW-7
97	EHC-0108-101	L011184002	8/10/2001	STW-8
109	EHC-0108-102	L011184003	8/10/2001	STW-9
9	EHC-0111-126	L011563018	11/9/2001	DH-24
21	EHC-0111-153	L011535018	11/8/2001	DH-50
11	EHC-0205-131	L020412029	6/1/2002	DH-24
23	EHC-0205-158	L020398002	5/30/2002	DH-50
12	EHC-0211-128	L020959007	11/18/2002	DH-24
24	EHC-0211-156	L020943008	11/13/2002	DH-50
32	EHC-0211-211	L020943010	11/13/2002	SPARGE 3
40	EHC-0211-212	L020943009	11/13/2002	STW-1
52	EHC-0211-213	L020943006	11/13/2002	STW-2
62	EHC-0211-214	L020943004	11/13/2002	STW-3
71	EHC-0211-215	L020943001	11/13/2002	STW-4
80	EHC-0211-216	L020943002	11/13/2002	STW-5
87	EHC-0211-217	L020943003	11/13/2002	STW-6
96	EHC-0211-218	L020943007	11/13/2002	STW-7
107	EHC-0211-219	0211-219	11/13/2002	STW-8
113	EHC-0211-220	L020943005	11/13/2002	STW-9
80	EHC-0211-239A	L020943013	11/13/2002	STW-5
13	EHC-0211-250	L020959008	11/18/2002	DH-24
33	EHST-0005-100	L000720001	5/10/2000	STW-1
52	EHST-0005-101	L000720002	5/10/2000	STW-3
81	EHST-0005-102	L000720003	5/10/2000	STW-6
72	EHST-0005-103	L000720004	5/10/2000	STW-5
63	EHST-0005-104	L000720005	5/10/2000	STW-4

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

Run Time: 12/10/2004 9:36:30 AM

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Table of Contents by Sample ID

<u>Page</u>	<u>Sample ID</u>	<u>Lab Sample ID</u>	<u>Sample Date</u>	<u>Station Name</u>
41	EHST-0005-105	L000720006	5/10/2000	STW-2
33	EHST-0005-110	L000759001	5/18/2000	STW-1
72	EHST-0005-111	L000759002	5/18/2000	STW-5
63	EHST-0005-112	L000759003	5/18/2000	STW-4
41	EHST-0005-113	L000759004	5/18/2000	STW-2
53	EHST-0005-114	L000759005	5/18/2000	STW-3
81	EHST-0005-115	L000759006	5/18/2000	STW-6
14	EHST-0005-117	L000759008	5/18/2000	DH-50
14	EHST-0005-118	L000759009	5/18/2000	DH-50
16	EHST-0005-120	L000825001	5/30/2000	DH-50
63	EHST-0005-121	L000825002	5/30/2000	STW-4
72	EHST-0005-122	L000825003	5/30/2000	STW-5
81	EHST-0005-123	L000825004	5/30/2000	STW-6
53	EHST-0005-124	L000825005	5/30/2000	STW-3
41	EHST-0005-125	L000825006	5/30/2000	STW-2
33	EHST-0005-126	L000825007	5/30/2000	STW-1
35	EHST-0005-127	L000825008	5/30/2000	STW-1
27	EHST-0005-129	L000825010	5/30/2000	SPARGE 3
16	EHST-0006-100	L000882001	6/6/2000	DH-50
74	EHST-0006-101	L000882002	6/6/2000	STW-5
63	EHST-0006-102	L000882003	6/6/2000	STW-4
43	EHST-0006-103	L000882004	6/6/2000	STW-2
81	EHST-0006-104	L000882005	6/6/2000	STW-6
81	EHST-0006-105	L000882006	6/6/2000	STW-6
53	EHST-0006-106	L000882007	6/6/2000	STW-3
35	EHST-0006-108	L000882009	6/6/2000	STW-1
16	EHST-0006-200	L000910001	6/13/2000	DH-50
74	EHST-0006-201	L000910002	6/13/2000	STW-5
81	EHST-0006-202	L000910003	6/13/2000	STW-6
53	EHST-0006-203	L000910004	6/13/2000	STW-3
43	EHST-0006-204	L000910005	6/13/2000	STW-2
63	EHST-0006-205	L000910000	6/13/2000	STW-4
63	EHST-0006-206	L000910007	6/13/2000	STW-4
35	EHST-0006-207	L000910008	6/13/2000	STW-1
16	EHST-0006-302	L000964003	6/21/2000	DH-50
74	EHST-0006-303	L000964004	6/21/2000	STW-5
82	EHST-0006-304	L000964005	6/21/2000	STW-6
53	EHST-0006-305	L000964006	6/21/2000	STW-3
43	EHST-0006-306	L000964007	6/21/2000	STW-2
64	EHST-0006-307	P000343	6/21/2000	STW-4
64	EHST-0006-307	L000964008	6/21/2000	STW-4
35	EHST-0006-308	L000964009	6/21/2000	STW-1

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

Run Time: 12/10/2004 9:36:30 AM

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB
ASARCO, East Helena Plant

Table of Contents by Sample ID

<u>Page</u>	<u>Sample ID</u>	<u>Lab Sample ID</u>	<u>Sample Date</u>	<u>Station Name</u>
1	EHST-0006-310	L000964011	6/21/2000	DH-24
16	EHST-0006-400	L001003001	6/29/2000	DH-50
74	EHST-0006-401	L001003002	6/29/2000	STW-5
82	EHST-0006-402	L001003003	6/29/2000	STW-6
53	EHST-0006-403	L001003004	6/29/2000	STW-3
43	EHST-0006-404	L001003005	6/29/2000	STW-2
64	EHST-0006-405	L001003006	6/29/2000	STW-4
35	EHST-0006-407	L001003008	6/29/2000	STW-1
35	EHST-0006-408	L001003009	6/29/2000	STW-1
16	EHST-0007-100	L001116001	7/13/2000	DH-50
74	EHST-0007-101	L001116002	7/13/2000	STW-5
82	EHST-0007-102	L001116003	7/13/2000	STW-6
54	EHST-0007-103	L001116004	7/13/2000	STW-3
43	EHST-0007-104	L001116005	7/13/2000	STW-2
64	EHST-0007-105	L001116006	7/13/2000	STW-4
64	EHST-0007-106	L001116007	7/13/2000	STW-4
36	EHST-0007-108	L001116009	7/13/2000	STW-1
17	EHST-0007-200	L001190001	7/24/2000	DH-50
74	EHST-0007-201	L001190002	7/24/2000	STW-5
64	EHST-0007-202	L001190003	7/24/2000	STW-4
43	EHST-0007-203	L001190004	7/24/2000	STW-2
54	EHST-0007-204	L001190005	7/24/2000	STW-3
54	EHST-0007-205	L001190006	7/24/2000	STW-3
82	EHST-0007-206	L001190007	7/24/2000	STW-6
36	EHST-0007-208	L001190009	7/24/2000	STW-1
17	EHST-0008-101	L001239002	8/3/2000	DH-50
75	EHST-0008-102	L001239003	8/3/2000	STW-5
82	EHST-0008-103	L001239004	8/3/2000	STW-6
54	EHST-0008-104	L001239005	8/3/2000	STW-3
44	EHST-0008-105	L001239006	8/3/2000	STW-2
65	EHST-0008-106	L001239007	8/3/2000	STW-4
36	EHST-0008-108	L001239009	8/3/2000	STW-1
27	EHST-0008-109	L001239010	8/3/2000	SPARGE 3
27	EHST-0008-110	L001239011	8/3/2000	SPARGE 3
1	EHST-0008-111	L001239012	8/3/2000	DH-24
17	EHST-0008-201	L001333002	8/16/2000	DH-50
75	EHST-0008-202	L001333003	8/16/2000	STW-5
82	EHST-0008-203	L001333004	8/16/2000	STW-6
54	EHST-0008-204	L001333005	8/16/2000	STW-3
44	EHST-0008-205	L001333006	8/16/2000	STW-2
65	EHST-0008-206	L001333007	8/16/2000	STW-4
36	EHST-0008-208	L001333009	8/16/2000	STW-1

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

Run Time: 12/10/2004 9:36:30 AM

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Table of Contents by Sample ID

<u>Page</u>	<u>Sample ID</u>	<u>Lab Sample ID</u>	<u>Sample Date</u>	<u>Station Name</u>
27	EHST-0008-209	L001333010	8/16/2000	SPARGE 3
1	EHST-0008-210	L001333011	8/16/2000	DH-24
1	EHST-0008-211	L001333012	8/16/2000	DH-24
17	EHST-0008-301	L001441002	8/31/2000	DH-50
65	EHST-0008-302	L001441003	8/31/2000	STW-4
75	EHST-0008-303	L001441004	8/31/2000	STW-5
83	EHST-0008-304	L001441005	8/31/2000	STW-6
54	EHST-0008-305	L001441006	8/31/2000	STW-3
44	EHST-0008-306	L001441007	8/31/2000	STW-2
36	EHST-0008-307	L001441008	8/31/2000	STW-1
28	EHST-0008-309	L001441010	8/31/2000	SPARGE 3
3	EHST-0008-310	L001441011	8/31/2000	DH-24
3	EHST-0008-311	L001441012	8/31/2000	DH-24
17	EHST-0009-101	L001513002	9/13/2000	DH-50
75	EHST-0009-102	L001513003	9/13/2000	STW-5
83	EHST-0009-103	L001513004	9/13/2000	STW-6
55	EHST-0009-104	L001513005	9/13/2000	STW-3
44	EHST-0009-105	L001513006	9/13/2000	STW-2
44	EHST-0009-106	L001513007	9/13/2000	STW-2
65	EHST-0009-107	L001513008	9/13/2000	STW-4
36	EHST-0009-109	L001513010	9/13/2000	STW-1
28	EHST-0009-110	L001513011	9/13/2000	SPARGE 3
3	EHST-0009-111	L001513012	9/13/2000	DH-24
3	EHST-0009-202	L001585003	9/22/2000	DH-24
3	EHST-0009-203	L001585004	9/22/2000	DH-24
28	EHST-0009-205	L001585006	9/22/2000	SPARGE 3
17	EHST-0010-101	L001649002	10/3/2000	DH-50
65	EHST-0010-102	L001649003	10/3/2000	STW-4
44	EHST-0010-103	L001649004	10/3/2000	STW-2
55	EHST-0010-104	L001649005	10/3/2000	STW-3
83	EHST-0010-105	L001649006	10/3/2000	STW-6
75	EHST-0010-106	L001649007	10/3/2000	STW-5
37	EHST-0010-107	L001649008	10/3/2000	STW-1
3	EHST-0010-108	L001649009	10/3/2000	DH-24
4	EHST-0010-109	L001649010	10/3/2000	DH-24
28	EHST-0010-111	L001649012	10/3/2000	SPARGE 3
28	EHST-0010-202	L001753003	10/17/2000	SPARGE 3
4	EHST-0010-204	L001753005	10/17/2000	DH-24
4	EHST-0010-205	L001753006	10/17/2000	DH-24
18	EHST-0011-102	L001861003	11/3/2000	DH-50
65	EHST-0011-103	L001861004	11/3/2000	STW-4
37	EHST-0011-104	L001861005	11/3/2000	STW-1

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

Run Time: 12/10/2004 9:36:30 AM

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Table of Contents by Sample ID

<u>Page</u>	<u>Sample ID</u>	<u>Lab Sample ID</u>	<u>Sample Date</u>	<u>Station Name</u>
28	EHST-0011-105	L001861006	11/3/2000	SPARGE 3
29	EHST-0011-106	L001861007	11/3/2000	SPARGE 3
4	EHST-0011-108	L001861009	11/3/2000	DH-24
37	EHST-0012-101	L002044002	12/20/2000	STW-1
18	EHST-0012-102	L002044003	12/20/2000	DH-50
66	EHST-0012-103	L002044004	12/20/2000	STW-4
75	EHST-0012-104	L002044005	12/20/2000	STW-5
45	EHST-0012-106	L002044007	12/20/2000	STW-2
83	EHST-0012-107	L002044008	12/20/2000	STW-6
55	EHST-0012-108	L002044009	12/20/2000	STW-3
29	EHST-0012-109	L002044010	12/20/2000	SPARGE 3
29	EHST-0012-110	L002044011	12/20/2000	SPARGE 3
4	EHST-0012-111	L002044012	12/20/2000	DH-24
29	EHST-0102-102	L010183003	2/7/2001	SPARGE 3
6	EHST-0102-103	L010183004	2/7/2001	DH-24
18	EHST-0102-104	L010183005	2/7/2001	DH-50
18	EHST-0102-105	L010183006	2/7/2001	DH-50
66	EHST-0102-106	L010183007	2/7/2001	STW-4
76	EHST-0102-107	L010183008	2/7/2001	STW-5
37	EHST-0102-108	L010183009	2/7/2001	STW-1
21	EHST-0109-100	L011367001	9/26/2001	DH-50
66	EHST-0109-101	L011367002	9/26/2001	STW-4
76	EHST-0109-102	L011367003	9/26/2001	STW-5
83	EHST-0109-103	L011367004	9/26/2001	STW-6
55	EHST-0109-104	L011367005	9/26/2001	STW-3
45	EHST-0109-105	L011367006	9/26/2001	STW-2
109	EHST-0109-106	L011367007	9/26/2001	STW-9
97	EHST-0109-107	L011367008	9/26/2001	STW-8
88	EHST-0109-108	L011367009	9/26/2001	STW-7
37	EHST-0109-109	L011367010	9/26/2001	STW-1
29	EHST-0109-110	L011367011	9/26/2001	SPARGE 3
6	EHST-0109-111	L011367012	9/26/2001	DH-24
6	EHST-0109-112	L011367013	9/26/2001	DH-24
30	EHST-0110-100	FIELD ONLY	10/19/2001	SPARGE 3
45	EHST-0110-101	FIELD ONLY	10/19/2001	STW-2
55	EHST-0110-102	FIELD ONLY	10/19/2001	STW-3
66	EHST-0110-103	FIELD ONLY	10/19/2001	STW-4
76	EHST-0110-104	FIELD ONLY	10/19/2001	STW-5
84	EHST-0110-105	FIELD ONLY	10/19/2001	STW-6
88	EHST-0110-106	FIELD ONLY	10/19/2001	STW-7
99	EHST-0110-107	FIELD ONLY	10/19/2001	STW-8
109	EHST-0110-108	FIELD ONLY	10/19/2001	STW-9

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

Run Time: 12/10/2004 9:36:30 AM

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB
ASARCO, East Helena Plant

Table of Contents by Sample ID

<u>Page</u>	<u>Sample ID</u>	<u>Lab Sample ID</u>	<u>Sample Date</u>	<u>Station Name</u>
6	EHST-0110-109	FIELD ONLY	10/19/2001	DH-24
21	EHST-0110-110	FIELD ONLY	10/19/2001	DH-50
30	EHST-0111-100	FIELD ONLY	11/2/2001	SPARGE 3
38	EHST-0111-101	FIELD ONLY	11/2/2001	STW-1
45	EHST-0111-102	FIELD ONLY	11/2/2001	STW-2
56	EHST-0111-103	FIELD ONLY	11/2/2001	STW-3
66	EHST-0111-104	FIELD ONLY	11/2/2001	STW-4
76	EHST-0111-105	FIELD ONLY	11/2/2001	STW-5
84	EHST-0111-106	FIELD ONLY	11/2/2001	STW-6
88	EHST-0111-107	FIELD ONLY	11/2/2001	STW-7
99	EHST-0111-108	FIELD ONLY	11/2/2001	STW-8
109	EHST-0111-109	FIELD ONLY	11/2/2001	STW-9
6	EHST-0111-110	FIELD ONLY	11/2/2001	DH-24
21	EHST-0111-111	FIELD ONLY	11/2/2001	DH-50
30	EHST-0111-200	L011587001	11/20/2001	SPARGE 3
9	EHST-0111-201	L011587002	11/20/2001	DH-24
21	EHST-0111-202	L011587003	11/20/2001	DH-50
67	EHST-0111-203	L011587004	11/20/2001	STW-4
99	EHST-0111-204	L011587005	11/20/2001	STW-8
76	EHST-0111-205	L011587006	11/20/2001	STW-5
84	EHST-0111-206	L011587007	11/20/2001	STW-6
88	EHST-0111-207	L011587008	11/20/2001	STW-7
56	EHST-0111-208	L011587009	11/20/2001	STW-3
46	EHST-0111-209	L011587010	11/20/2001	STW-2
38	EHST-0111-210	L011587011	11/20/2001	STW-1
109	EHST-0111-211	L011587012	11/20/2001	STW-9
46	EHST-0111-300	L011606001	11/30/2001	STW-2
56	EHST-0111-301	L011606002	11/30/2001	STW-3
88	EHST-0111-302	L011606003	11/30/2001	STW-7
99	EHST-0111-303	L011606004	11/30/2001	STW-8
109	EHST-0111-304	L011606005	11/30/2001	STW-9
46	EHST-0112-100	L011614001	12/4/2001	STW-2
56	EHST-0112-101	L011614002	12/4/2001	STW-3
89	EHST-0112-102	L011614003	12/4/2001	STW-7
99	EHST-0112-103	L011614004	12/4/2001	STW-8
110	EHST-0112-104	L011614005	12/4/2001	STW-9
9	EHST-0112-200	L011626001	12/7/2001	DH-24
30	EHST-0112-201	L011626002	12/7/2001	SPARGE 3
21	EHST-0112-202	L011626003	12/7/2001	DH-50
67	EHST-0112-203	L011626004	12/7/2001	STW-4
77	EHST-0112-204	L011626005	12/7/2001	STW-5
84	EHST-0112-205	L011626006	12/7/2001	STW-6

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

Run Time: 12/10/2004 9:36:30 AM

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Table of Contents by Sample ID

<u>Page</u>	<u>Sample ID</u>	<u>Lab Sample ID</u>	<u>Sample Date</u>	<u>Station Name</u>
46	EHST-0112-206	L011626007	12/7/2001	STW-2
110	EHST-0112-207	L011626008	12/7/2001	STW-9
56	EHST-0112-208	L011626009	12/7/2001	STW-3
99	EHST-0112-209	L011626010	12/7/2001	STW-8
89	EHST-0112-210	L011626011	12/7/2001	STW-7
38	EHST-0112-211	L011626012	12/7/2001	STW-1
46	EHST-0112-250	FIELD ONLY	12/12/2001	STW-2
56	EHST-0112-251	FIELD ONLY	12/12/2001	STW-3
89	EHST-0112-252	FIELD ONLY	12/12/2001	STW-7
100	EHST-0112-253	FIELD ONLY	12/12/2001	STW-8
110	EHST-0112-254	FIELD ONLY	12/12/2001	STW-9
22	EHST-0112-300	L011652001	12/14/2001	DH-50
67	EHST-0112-301	L011652002	12/14/2001	STW-4
77	EHST-0112-302	L011652003	12/14/2001	STW-5
84	EHST-0112-303	L011652004	12/14/2001	STW-6
46	EHST-0112-304	L011652005	12/14/2001	STW-2
110	EHST-0112-305	L011652006	12/14/2001	STW-9
57	EHST-0112-306	L011652007	12/14/2001	STW-3
100	EHST-0112-307	L011652008	12/14/2001	STW-8
89	EHST-0112-308	L011652009	12/14/2001	STW-7
9	EHST-0112-400	L011661001	12/19/2001	DH-24
30	EHST-0112-401	L011661002	12/19/2001	SPARGE 3
22	EHST-0112-402	L011661003	12/19/2001	DH-50
67	EHST-0112-403	L011661004	12/19/2001	STW-4
110	EHST-0112-404	L011661005	12/19/2001	STW-9
47	EHST-0112-405	L011661006	12/19/2001	STW-2
77	EHST-0112-406	L011661007	12/19/2001	STW-5
84	EHST-0112-407	L011661008	12/19/2001	STW-6
57	EHST-0112-408	L011661009	12/19/2001	STW-3
100	EHST-0112-409	L011661010	12/19/2001	STW-8
89	EHST-0112-410	L011661011	12/19/2001	STW-7
38	EHST-0112-411	L011661012	12/19/2001	STW-1
22	EHST-0112-500	L011677001	12/27/2001	DH-50
67	EHST-0112-501	L011677002	12/27/2001	STW-4
77	EHST-0112-502	L011677003	12/27/2001	STW-5
85	EHST-0112-503	L011677004	12/27/2001	STW-6
47	EHST-0112-504	L011677005	12/27/2001	STW-2
110	EHST-0112-505	L011677006	12/27/2001	STW-9
57	EHST-0112-506	L011677007	12/27/2001	STW-3
100	EHST-0112-507	L011677008	12/27/2001	STW-8
89	EHST-0112-508	L011677009	12/27/2001	STW-7
38	EHST-0201-100	L020025001	1/10/2002	STW-1

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

Run Time: 12/10/2004 9:36:30 AM

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB
ASARCO, East Helena Plant

Table of Contents by Sample ID

<u>Page</u>	<u>Sample ID</u>	<u>Lab Sample ID</u>	<u>Sample Date</u>	<u>Station Name</u>
90	EHST-0201-101	L020025002	1/10/2002	STW-7
100	EHST-0201-102	L020025003	1/10/2002	STW-8
67	EHST-0201-103	L020025004	1/10/2002	STW-4
77	EHST-0201-104	L020025005	1/10/2002	STW-5
47	EHST-0201-105	L020025006	1/10/2002	STW-2
111	EHST-0201-106	L020025007	1/10/2002	STW-9
57	EHST-0201-107	L020025008	1/10/2002	STW-3
85	EHST-0201-108	L020025009	1/10/2002	STW-6
30	EHST-0201-109	L020024001	1/10/2002	SPARGE 3
9	EHST-0201-110	L020024002	1/10/2002	DH-24
22	EHST-0201-111	L020024003	1/11/2002	DH-50
22	EHST-0201-200	L020027001	1/16/2002	DH-50
100	EHST-0201-201	L020027002	1/16/2002	STW-8
90	EHST-0201-202	L020027003	1/16/2002	STW-7
68	EHST-0201-203	L020027004	1/16/2002	STW-4
77	EHST-0201-204	L020027005	1/16/2002	STW-5
111	EHST-0201-205	L020027006	1/16/2002	STW-9
47	EHST-0201-206	L020027007	1/16/2002	STW-2
57	EHST-0201-207	L020027008	1/16/2002	STW-3
85	EHST-0201-208	L020027009	1/16/2002	STW-6
85	EHST-0201-209	L020027010	1/16/2002	STW-6
38	EHST-0201-300	L020042001	1/23/2002	STW-1
90	EHST-0201-301	L020042002	1/23/2002	STW-7
101	EHST-0201-302	L020042003	1/23/2002	STW-8
68	EHST-0201-303	L020042004	1/23/2002	STW-4
78	EHST-0201-304	L020042005	1/23/2002	STW-5
85	EHST-0201-305	L020042006	1/23/2002	STW-6
57	EHST-0201-306	L020042007	1/23/2002	STW-3
111	EHST-0201-307	L020042008	1/23/2002	STW-9
47	EHST-0201-308	L020042009	1/23/2002	STW-2
22	EHST-0201-309	L020042010	1/23/2002	DH-50
31	EHST-0201-310	L020042011	1/23/2002	SPARGE 3
9	EHST-0201-311	L020042012	1/23/2002	DH-24
11	EHST-0201-312	L020042013	1/23/2002	DH-24
91	EHST-0202-100	L020118001	2/22/2002	STW-7
102	EHST-0202-101	L020118002	2/22/2002	STW-8
78	EHST-0202-102	L020118003	2/22/2002	STW-5
112	EHST-0202-103	L020118004	2/22/2002	STW-9
48	EHST-0202-104	L020118005	2/22/2002	STW-2
59	EHST-0202-105	L020118006	2/22/2002	STW-3
39	EHST-0202-200	L020142001	2/27/2002	STW-1
102	EHST-0202-201	L020142002	2/27/2002	STW-8

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

Run Time: 12/10/2004 9:36:30 AM

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Table of Contents by Sample ID

<u>Page</u>	<u>Sample ID</u>	<u>Lab Sample ID</u>	<u>Sample Date</u>	<u>Station Name</u>
91	EHST-0202-202	L020142003	2/27/2002	STW-7
23	EHST-0202-203	L020142004	2/27/2002	DH-50
68	EHST-0202-204	L020142005	2/27/2002	STW-4
78	EHST-0202-205	L020142006	2/27/2002	STW-5
86	EHST-0202-206	L020142007	2/27/2002	STW-6
59	EHST-0202-207	L020142008	2/27/2002	STW-3
112	EHST-0202-208	L020142009	2/27/2002	STW-9
49	EHST-0202-209	L020142010	2/27/2002	STW-2
11	EHST-0202-400	L020075001	2/5/2002	DH-24
31	EHST-0202-401	L020075002	2/5/2002	SPARGE 3
23	EHST-0202-402	L020075003	2/5/2002	DH-50
68	EHST-0202-403	L020075004	2/5/2002	STW-4
78	EHST-0202-404	L020075005	2/5/2002	STW-5
85	EHST-0202-405	L020075006	2/5/2002	STW-6
58	EHST-0202-406	L020075007	2/5/2002	STW-3
111	EHST-0202-407	L020075008	2/5/2002	STW-9
47	EHST-0202-408	L020075009	2/5/2002	STW-2
90	EHST-0202-409	L020075010	2/5/2002	STW-7
90	EHST-0202-410	L020075011	2/5/2002	STW-7
101	EHST-0202-411	L020075012	2/5/2002	STW-8
39	EHST-0202-412	L020075013	2/5/2002	STW-1
90	EHST-0202-500	L020096001	2/12/2002	STW-7
101	EHST-0202-501	L020096002	2/12/2002	STW-8
48	EHST-0202-502	L020096003	2/12/2002	STW-2
111	EHST-0202-503	L020096004	2/12/2002	STW-9
58	EHST-0202-504	L020096005	2/12/2002	STW-3
48	EHST-0202-600	L020096006	2/13/2002	STW-2
111	EHST-0202-601	L020096007	2/13/2002	STW-9
58	EHST-0202-602	L020096008	2/13/2002	STW-3
101	EHST-0202-603	L020096009	2/13/2002	STW-8
91	EHST-0202-604	L020096010	2/13/2002	STW-7
112	EHST-0202-700	L020101001	2/14/2002	STW-9
48	EHST-0202-701	L020101002	2/14/2002	STW-2
58	EHST-0202-702	L020101003	2/14/2002	STW-3
101	EHST-0202-703	L020101004	2/14/2002	STW-8
91	EHST-0202-704	L020101005	2/14/2002	STW-7
112	EHST-0202-800	L020101006	2/15/2002	STW-9
48	EHST-0202-801	L020101007	2/15/2002	STW-2
58	EHST-0202-802	L020101008	2/15/2002	STW-3
101	EHST-0202-803	L020101009	2/15/2002	STW-8
91	EHST-0202-804	L020101010	2/15/2002	STW-7
11	EHST-0202-900	L020110001	2/19/2002	DH-24

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

Run Time: 12/10/2004 9:36:30 AM

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Table of Contents by Sample ID

<u>Page</u>	<u>Sample ID</u>	<u>Lab Sample ID</u>	<u>Sample Date</u>	<u>Station Name</u>
31	EHST-0202-901	L020110002	2/19/2002	SPARGE 3
23	EHST-0202-902	L020110003	2/19/2002	DH-50
112	EHST-0202-903	L020110004	2/19/2002	STW-9
48	EHST-0202-904	L020110005	2/19/2002	STW-2
58	EHST-0202-905	L020110006	2/19/2002	STW-3
86	EHST-0202-906	L020110007	2/19/2002	STW-6
78	EHST-0202-907	L020110008	2/19/2002	STW-5
68	EHST-0202-908	L020110009	2/19/2002	STW-4
102	EHST-0202-909	L020110010	2/19/2002	STW-8
102	EHST-0202-910	L020110011	2/19/2002	STW-8
91	EHST-0202-911	L020110012	2/19/2002	STW-7
39	EHST-0202-912	L020110013	2/19/2002	STW-1
11	EHST-0204-100	L020278001	4/19/2002	DH-24
31	EHST-0204-101	L020278002	4/19/2002	SPARGE 3
112	EHST-0204-102	L020278003	4/19/2002	STW-9
49	EHST-0204-103	L020278004	4/19/2002	STW-2
78	EHST-0204-104	L020278005	4/19/2002	STW-5
68	EHST-0204-105	L020278006	4/19/2002	STW-4
86	EHST-0204-106	L020278007	4/19/2002	STW-6
59	EHST-0204-107	L020278008	4/19/2002	STW-3
102	EHST-0204-108	L020278009	4/19/2002	STW-8
92	EHST-0204-109	L020278010	4/19/2002	STW-7
39	EHST-0204-110	L020278011	4/19/2002	STW-1
11	EHST-0205-100	L020364001	5/10/2002	DH-24
31	EHST-0205-101	L020364002	5/10/2002	SPARGE 3
79	EHST-0205-102	L020364003	5/10/2002	STW-5
69	EHST-0205-103	L020364004	5/10/2002	STW-4
59	EHST-0205-103A	205103	5/10/2002	STW-3
102	EHST-0205-104	L020364005	5/10/2002	STW-8
92	EHST-0205-105	L020364006	5/10/2002	STW-7
49	EHST-0205-106	205106	5/10/2002	STW-2
86	EHST-0205-107	205107	5/10/2002	STW-6
113	EHST-0205-108	205108	5/10/2002	STW-9
39	EHST-0205-110	205110	5/10/2002	STW-1
23	EHST-0205-111	205111	5/10/2002	DH-50
12	EHST-0206-100	L020426001	6/6/2002	DH-24
69	EHST-0206-101	L020426002	6/6/2002	STW-4
49	EHST-0206-102	L020426003	6/6/2002	STW-2
79	EHST-0206-103	L020426004	6/6/2002	STW-5
113	EHST-0206-104	L020426005	6/6/2002	STW-9
86	EHST-0206-105	L020426006	6/6/2002	STW-6
59	EHST-0206-106	L020426007	6/6/2002	STW-3

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

Run Time: 12/10/2004 9:36:30 AM

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroData\DB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Table of Contents by Sample ID

<u>Page</u>	<u>Sample ID</u>	<u>Lab Sample ID</u>	<u>Sample Date</u>	<u>Station Name</u>
103	EHST-0206-107	L020426008	6/6/2002	STW-8
92	EHST-0206-108	L020426009	6/6/2002	STW-7
39	EHST-0206-109	206109	6/6/2002	STW-1
31	EHST-0206-110	206110	6/6/2002	SPARGE 3
103	EHST-0207-100	L020591001	7/17/2002	STW-8
92	EHST-0207-101	L020591002	7/17/2002	STW-7
40	EHST-0207-102	207102	7/17/2002	STW-1
59	EHST-0207-103	L020591003	7/17/2002	STW-3
69	EHST-0207-104	L020591004	7/17/2002	STW-4
49	EHST-0207-105	L020591005	7/17/2002	STW-2
92	EHST-0207-200	L020591006	7/19/2002	STW-7
103	EHST-0207-201	L020591007	7/19/2002	STW-8
92	EHST-0207-300	L020594001	7/24/2002	STW-7
103	EHST-0207-301	L020594002	7/24/2002	STW-8
49	EHST-0207-302	L020594003	7/24/2002	STW-2
69	EHST-0207-303	L020594004	7/24/2002	STW-4
60	EHST-0207-304	L020594005	7/24/2002	STW-3
40	EHST-0207-305	207305	7/24/2002	STW-1
103	EHST-0207-400	L020594006	7/25/2002	STW-8
93	EHST-0207-401	L020594007	7/25/2002	STW-7
93	EHST-0207-500	L020606001	7/31/2002	STW-7
103	EHST-0207-501	L020606002	7/31/2002	STW-8
60	EHST-0207-502	L020606003	7/31/2002	STW-3
50	EHST-0207-503	L020606004	7/31/2002	STW-2
69	EHST-0207-504	L020606005	7/31/2002	STW-4
93	EHST-0207-600	L020606006	8/1/2002	STW-7
104	EHST-0207-601	L020606007	8/1/2002	STW-8
12	EHST-0208-100	L020638001	8/8/2002	DH-24
32	EHST-0208-101	L020638002	8/8/2002	SPARGE 3
40	EHST-0208-102	L020638003	8/8/2002	STW-1
104	EHST-0208-103	L020638004	8/8/2002	STW-8
93	EHST-0208-104	L020638005	8/8/2002	STW-7
113	EHST-0208-105	L020638006	8/8/2002	STW-9
50	EHST-0208-106	L020638007	8/8/2002	STW-2
79	EHST-0208-107	L020638008	8/8/2002	STW-5
79	EHST-0208-107RR	L020685001	8/8/2002	STW-5
69	EHST-0208-108	L020642001	8/8/2002	STW-4
23	EHST-0208-109	L020642002	8/8/2002	DH-50
60	EHST-0208-110	L020642003	8/8/2002	STW-3
86	EHST-0208-111	L020642004	8/8/2002	STW-6
104	EHST-0208-200	L020642005	8/9/2002	STW-8
93	EHST-0208-201	L020642006	8/9/2002	STW-7

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

Run Time: 12/10/2004 9:36:30 AM

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Table of Contents by Sample ID

<u>Page</u>	<u>Sample ID</u>	<u>Lab Sample ID</u>	<u>Sample Date</u>	<u>Station Name</u>
93	EHST-0208-300	L020650001	8/14/2002	STW-7
104	EHST-0208-301	L020650002	8/14/2002	STW-8
60	EHST-0208-302	L020650003	8/14/2002	STW-3
50	EHST-0208-303	L020650004	8/14/2002	STW-2
70	EHST-0208-304	L020650005	8/14/2002	STW-4
94	EHST-0208-400	L020650006	8/15/2002	STW-7
104	EHST-0208-401	L020650007	8/15/2002	STW-8
94	EHST-0208-500	L020686001	8/22/2002	STW-7
104	EHST-0208-501	L020686002	8/22/2002	STW-8
50	EHST-0208-502	L020686005	8/22/2002	STW-2
60	EHST-0208-503	L020686003	8/22/2002	STW-3
70	EHST-0208-504	L020686004	8/22/2002	STW-4
94	EHST-0208-600	L020705001	8/28/2002	STW-7
105	EHST-0208-601	L020705002	8/28/2002	STW-8
50	EHST-0208-602	L020705003	8/28/2002	STW-2
60	EHST-0208-603	L020705004	8/28/2002	STW-3
70	EHST-0208-604	L020705005	8/28/2002	STW-4
94	EHST-0209-100	L020731001	9/4/2002	STW-7
105	EHST-0209-101	L020731002	9/4/2002	STW-8
50	EHST-0209-102	L020731003	9/4/2002	STW-2
61	EHST-0209-103	L020731004	9/5/2002	STW-3
70	EHST-0209-104	L020731005	9/4/2002	STW-4
94	EHST-0209-200	L020749001	9/6/2002	STW-7
105	EHST-0209-201	L020749002	9/6/2002	STW-8
12	EHST-0209-300	L020775001	9/12/2002	DH-24
94	EHST-0209-301	L020775002	9/12/2002	STW-7
105	EHST-0209-302	L020775003	9/12/2002	STW-8
95	EHST-0209-400	L020785001	9/19/2002	STW-7
105	EHST-0209-401	L020785002	9/19/2002	STW-8
70	EHST-0209-402	L020785003	9/19/2002	STW-4
51	EHST-0209-403	L020785004	9/19/2002	STW-2
61	EHST-0209-404	L020785005	9/19/2002	STW-3
95	EHST-0209-500	L020785006	9/20/2002	STW-7
105	EHST-0209-501	L020785007	9/20/2002	STW-8
12	EHST-0209-600	L020829001	9/26/2002	DH-24
12	EHST-0209-600A	L020829009	9/26/2002	DH-24
32	EHST-0209-601	L020829002	9/26/2002	SPARGE 3
24	EHST-0209-602	L020829003	9/26/2002	DH-50
87	EHST-0209-603	L020829004	9/26/2002	STW-6
61	EHST-0209-604	L020829005	9/26/2002	STW-3
79	EHST-0209-605	L020829006	9/26/2002	STW-5
113	EHST-0209-606	L020829007	9/26/2002	STW-9

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Run Time: 12/10/2004 9:36:30 AM

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Table of Contents by Sample ID

<u>Page</u>	<u>Sample ID</u>	<u>Lab Sample ID</u>	<u>Sample Date</u>	<u>Station Name</u>
51	EHST-0209-607	L020829008	9/26/2002	STW-2
79	EHST-0209-608	L020829010	9/26/2002	STW-5
106	EHST-0209-609	L020829011	9/26/2002	STW-8
95	EHST-0209-610	L020829012	9/26/2002	STW-7
40	EHST-0209-611	209611	9/26/2002	STW-1
70	EHST-0210-100	L020845001	10/4/2002	STW-4
51	EHST-0210-101	L020845002	10/4/2002	STW-2
106	EHST-0210-102	L020845004	10/4/2002	STW-8
95	EHST-0210-103	L020845005	10/4/2002	STW-7
61	EHST-0210-104	L020845003	10/4/2002	STW-3
95	EHST-0210-200	L020845006	10/5/2002	STW-7
106	EHST-0210-201	L020845007	10/5/2002	STW-8
71	EHST-0210-300	L020869001	10/17/2002	STW-4
51	EHST-0210-301	L020869002	10/17/2002	STW-2
61	EHST-0210-302	L020869003	9/17/2002	STW-3
106	EHST-0210-303	L020869004	10/17/2002	STW-8
95	EHST-0210-304	L020869005	10/17/2002	STW-7
71	EHST-0210-400	L020888001	10/23/2002	STW-4
51	EHST-0210-401	L020888002	10/23/2002	STW-2
61	EHST-0210-402	L020888003	10/23/2002	STW-3
106	EHST-0210-403	L020888004	10/23/2002	STW-8
96	EHST-0210-404	L020888005	10/23/2002	STW-7
71	EHST-0210-500	L020915001	10/31/2002	STW-4
51	EHST-0210-501	L020915002	10/31/2002	STW-2
62	EHST-0210-502	L020915003	10/31/2002	STW-3
106	EHST-0210-503	L020915004	10/31/2002	STW-8
96	EHST-0210-504	L020915005	10/31/2002	STW-7
13	EHST-0212-100	L021034-001	12/17/2002	DH-24
13	EHST-0212-100	L021034001	12/17/2002	DH-24
13	EHST-0212-100	L030016-001	1/14/2003	DH-24
32	EHST-0212-101	L021034002	12/17/2002	SPARGE 3
32	EHST-0212-101	L021034-002	12/17/2002	SPARGE 3
96	EHST-0212-101	L030016-002	1/14/2003	STW-7
96	EHST-0212-102	L021034-003	12/17/2002	STW-7
96	EHST-0212-102	L021034003	12/17/2002	STW-7
107	EHST-0212-102	L030016-003	1/14/2003	STW-8
107	EHST-0212-103	EHST-0212-103	12/17/2002	STW-8
62	EHST-0212-104	EHST-0212-104	12/17/2002	STW-3
71	EHST-0212-105	EHST-0212-105	12/17/2002	STW-4
14	IMMW-0004-120	L000630001	4/25/2000	DH-50
18	IMMW-0011-120	L001922019	11/15/2000	DH-50

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Run Time: 12/10/2004 9:36:30 AM

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	DH-24	DH-24	DH-24	DH-24	DH-24	DH-24
Water	SAMPLE DATE	5/1/2000	5/1/2000	6/21/2000	8/3/2000	8/16/2000	8/16/2000
	SAMPLE TIME	10:30	10:45	15:25	13:30	14:15	14:30
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L000703007	L000704005	L000964011	L001239012	L001333011	L001333012
	SAMPLE NUMBER	EHC-0005-126	EHC-0005-162	EHST-0006-310	EHST-0008-111	EHST-0008-210	EHST-0008-211
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS		Field Duplicate				Field Duplicate
Common Ions: ppm unless noted							
	Bicarbonate (HCO3)	73	62	5			
	Calcium (Ca) (DIS)	54	49	46	46		
	Carbonate As CO3	<1	<1	<1	<1		
	Chloride (Cl)	44	44	35	30		
	Magnesium (Mg) (DIS)	22	21	19	18		
	Potassium (K) (DIS)	14	13	10	12		
	Sodium (Na) (DIS)	129	113	117	109		
	Sulfate (SO4)	412	435	381			
	Total Alkalinity As CaCO3	60	51				
Hydrocarbon: ppm unless noted							
	Diesel Range Organics	<0.5 UJ	<0.5 UJ				
	Diesel Range Organics as Diesel	<0.5 UJ	<0.5 UJ				
	Gasoline Range Organics	<0.02	<0.02				
	Gasoline Range Organics as Gasoline	<0.02	<0.02				
	Total Extractable Hydrocarbons	<0.5 UJ	0.5 J				
	Total Petroleum Hydrocarbons	0.6	<0.1				
	Total Purgeable Hydrocarbons	0.1	0.09				
Metals: ppm unless noted							
	Arsenic (As) (DIS)	20	19	16	20	16	16
	Arsenic +3	16	17	13	14	13	14
	Arsenic +5	3.3	3.5	3.4	5.9 J	2.3	2.2
	Cadmium (Cd) (DIS)	0.1	0.1	0.1	0.1		
	Copper (Cu) (DIS)	0.01	0.01				
	Iron (Fe) (DIS)	12	12 J	7.5	11		
	Lead (Pb) (DIS)	<0.005	<0.005	<0.005	<0.005		
	Manganese (Mn) (DIS)	7.9	7.4	6.5	6.7		
	Zinc (Zn) (DIS)	4.7	4.7	4.5	4.3		
Physical/Fld-Lab: ppm unless noted							
	Iron (Fe) (Fld)			7.9		8	
	Iron (Fe+2) (Fld)			7.7	10.4	8.2	
	Oxygen (O) (DIS) (Fld)	3.6	3.6	1.3	0.9	0.9	0.9
	pH	6.1	6	6.1	6		
	Depth To Water Level (ft)	29.2		28	27.7	27.8	
	Eh (millivolts)	460	459	251	247	277	277
	pH (Fld)	6.02	6.01	5.9	6.2	6.4	6.4
	SC (umhos/cm at 25 C) (Fld)	1146	1147	1005	1120	1031	1036
	SC (umhos/cm at 25 C)	1123	1116	1024	1066		

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	DH-24	DH-24	DH-24	DH-24	DH-24	DH-24
Water	SAMPLE DATE	5/1/2000	5/1/2000	6/21/2000	8/3/2000	8/16/2000	8/16/2000
	SAMPLE TIME	10:30	10:45	15:25	13:30	14:15	14:30
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L000703007	L000704005	L000964011	L001239012	L001333011	L001333012
	SAMPLE NUMBER	EHC-0005-126	EHC-0005-162	EHST-0006-310	EHST-0008-111	EHST-0008-210	EHST-0008-211
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS		Field Duplicate				Field Duplicate

Physical/Fid-Lab: ppm unless noted

TDS (Measured at 180 C)	782	763				
Water Temperature (C) (Fid)	11.9	11.9	13	13.9	13.4	13.4

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	DH-24	DH-24	DH-24	DH-24	DH-24	DH-24
Water	SAMPLE DATE	8/31/2000	8/31/2000	9/13/2000	9/22/2000	9/22/2000	10/3/2000
	SAMPLE TIME	14:40	14:55	16:00	12:00	12:15	14:30
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L001441011	L001441012	L001513012	L001585003	L001585004	L001649009
	SAMPLE NUMBER	EHST-0008-310	EHST-0008-311	EHST-0009-111	EHST-0009-202	EHST-0009-203	EHST-0010-108
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RJ	RJ	RJ	RJ	RJ	RJ
	DESCRIPTION						
	REMARKS		Field Duplicate			Field Duplicate	

Metals: ppm unless noted

Arsenic (As) (DIS)	17	17	18	13	15	12
Arsenic +3	14	14	15	11	13	9.4
Arsenic +5	2.5	2.3	2	2.1	2.4	1.9

Physical/Fld-Lab: ppm unless noted

Iron (Fe) (Fld)	9.2			9.2		9
Iron (Fe+2) (Fld)	9			9.4		9
Oxygen (O) (DIS) (Fld)	0.7	0.7	1.3	0.7	0.8	0.7
Depth To Water Level (ft)	28.4		28.6	29.03		29.1
Eh (millivolts)	266	267	270	286	287	
pH (Fld)	6.2	6.2	6.7	6.2	6.3	5.8
SC (umhos/cm at 25 C) (Fld)	1006	980	1087	1055	1066	894
Water Temperature (C) (Fld)	13.1	13.1	13.5	10.8	10.8	11.9

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	DH-24	DH-24	DH-24	DH-24	DH-24	DH-24
Water	SAMPLE DATE	10/3/2000	10/17/2000	10/17/2000	11/3/2000	11/8/2000	12/20/2000
	SAMPLE TIME	14:45	15:40	15:55	14:20	12:05	15:15
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L001649010	L001753005	L001753006	L001861009	L001873001	L002044012
	SAMPLE NUMBER	EHST-0010-109	EHST-0010-204	EHST-0010-205	EHST-0011-108	EHC-0011-127	EHST-0012-111
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS	Field Duplicate		Field Duplicate			
Common Ions: ppm unless noted							
	Bicarbonate (HCO3)					27	46
	Calcium (Ca) (DIS)					36	35
	Carbonate As CO3					<1	<1
	Chloride (Cl)					32 J	28
	Magnesium (Mg) (DIS)					15	15
	Potassium (K) (DIS)					11	11
	Sodium (Na) (DIS)					106	116
	Sulfate (SO4)					354	337
	Total Alkalinity As CaCO3					22	38
Hydrocarbon: ppm unless noted							
	Diesel Range Organics					<0.5	
	Diesel Range Organics as Diesel					<0.5	
	Gasoline Range Organics					<0.02 J	
	Gasoline Range Organics as Gasoline					<0.02 J	
	Total Extractable Hydrocarbons					<0.5	
	Total Petroleum Hydrocarbons					<0.1	
	Total Purgeable Hydrocarbons					<0.02	
Metals: ppm unless noted							
	Aluminum (Al) (DIS)					0.7	
	Arsenic (As) (DIS)	12	3.9 J	4 J	4.3	3.6	11
	Arsenic +3	9.6	1.1	0.9	2.2	2.2	8.6
	Arsenic +5	2.2	3.3		1.9	1.4	2.5
	Cadmium (Cd) (DIS)					0.1	0.1
	Copper (Cu) (DIS)					0.03	0.02
	Iron (Fe) (DIS)					6.8	6
	Lead (Pb) (DIS)					0.005	0.007
	Manganese (Mn) (DIS)					5.2	5.4
	Zinc (Zn) (DIS)					3.2	3.2
Other: ppm unless noted							
	Silicon+Silica (Si+SiO2)					38	
Physical/Fld-Lab: ppm unless noted							
	Iron (Fe+2) (Fld)		4.4		5.8		6.4
	Oxygen (O) (DIS) (Fld)	0.7	1.3	1.3	1.03	2.6	1.01
	pH					5.9	6.2
	Depth To Water Level (ft)		29.1		28.7	28.8	29.6
	Eh (millivolts)		288	289	294	314	269
	pH (Fld)	5.8	5.9	5.9	6.03	6.2	6.2
	SC (umhos/cm at 25 C) (Fld)	896	905	921	922	966	1050

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	DH-24	DH-24	DH-24	DH-24	DH-24	DH-24
Water	SAMPLE DATE	10/3/2000	10/17/2000	10/17/2000	11/3/2000	11/8/2000	12/20/2000
	SAMPLE TIME	14:45	15:40	15:55	14:20	12:05	15:15
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L001649010	L001753005	L001753006	L001861009	L001873001	L002044012
	SAMPLE NUMBER	EHST-0010-109	EHST-0010-204	EHST-0010-205	EHST-0011-108	EHST-0011-127	EHST-0012-111
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RJ	RJ	RJ	RJ	RJ	RJ
	DESCRIPTION						
	REMARKS	Field Duplicate		Field Duplicate			

Physical/Fid-Lab: ppm unless noted

SC (umhos/cm at 25 C)					931	942
TDS (Measured at 180 C)					648	654
Water Temperature (C) (Fld)	11.9	12.8	12.8	11.5	11.2	11.1

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	DH-24	DH-24	DH-24	DH-24	DH-24	DH-24
Water	SAMPLE DATE	2/7/2001	5/10/2001	9/26/2001	9/26/2001	10/19/2001	11/2/2001
	SAMPLE TIME	10:50	15:20	13:25	13:40	15:45	09:44
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	HYDRO	HYDRO
	LAB NUMBER	L010183004	L010691022	L011367012	L011367013	FIELD ONLY	FIELD ONLY
	SAMPLE NUMBER	EHST-0102-103	EHC-0105-127	EHST-0109-111	EHST-0109-112	EHST-0110-109	EHST-0111-110
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS				Field Duplicate		

Common Ions: ppm unless noted

Bicarbonate (HCO3)	61	73	73
Calcium (Ca) (DIS)	41		
Carbonate As CO3		<1	<1
Chloride (Cl)	24		
Magnesium (Mg) (DIS)	17		
Potassium (K) (DIS)	13		
Sodium (Na) (DIS)	114 J		
Sulfate (SO4)	349	297	265
Total Alkalinity As CaCO3	50	60	60

Hydrocarbon: ppm unless noted

Diesel Range Organics	<0.5
Diesel Range Organics as Diesel	<0.5
Gasoline Range Organics	<0.02
Gasoline Range Organics as Gasoline	<0.02
Total Extractable Hydrocarbons	<0.5
Total Petroleum Hydrocarbons	<0.1
Total Purgeable Hydrocarbons	0.05

Metals: ppm unless noted

Aluminum (Al) (DIS)	0.7
Antimony (Sb) (DIS)	0.01
Arsenic (As) (DIS)	12
Arsenic +3	10
Arsenic +5	1.4
Cadmium (Cd) (DIS)	0.1
Copper (Cu) (DIS)	0.1
Iron (Fe) (DIS)	2.6
Lead (Pb) (DIS)	<0.003
Manganese (Mn) (DIS)	3.3
Mercury (Hg) (DIS)	0.0003
Selenium (Se) (DIS)	0.01
Thallium (Tl) (DIS)	<0.003
Zinc (Zn) (DIS)	2.6

Other: ppm unless noted

Benzo(j)Fluoranthene	<0.01
Silicon+Silica (Si+SiO2)	43

Physical/Fld-Lab: ppm unless noted

Iron (Fe) (Fld)		3.4	4.4	5.1
Iron (Fe+2) (Fld)		3.1	4	4.8
Oxygen (O) (DIS) (Fld)	1.4	7.3	0.9	0.8
pH		7.1		0.5
Depth To Water Level (ft)	30.3	30.3	26	26.5

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	DH-24	DH-24	DH-24	DH-24	DH-24	DH-24
Water	SAMPLE DATE	2/7/2001	5/10/2001	9/26/2001	9/26/2001	10/19/2001	11/2/2001
	SAMPLE TIME	10:50	15:20	13:25	13:40	15:45	09:44
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	HYDRO	HYDRO
	LAB NUMBER	L010183004	L010691022	L011367012	L011367013	FIELD ONLY	FIELD ONLY
	SAMPLE NUMBER	EHST-0102-103	EHC-0105-127	EHST-0109-111	EHST-0109-112	EHST-0110-109	EHST-0111-110
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS				Field Duplicate		

Physical/Fid-Lab: ppm unless noted

Eh (millivolts)	295	218	258	260	278	
pH (Fld)	6.6	6.5	5.5	5.4	6	5.9
SC (umhos/cm at 25 C) (Fld)	720	834	915	920	968	975
SC (umhos/cm at 25 C)		940				
Total Suspended Solids		16				
TDS (Measured at 180 C)		657				
Water Temperature (C) (Fld)	9.1	12.8	11.7	11.7	11.4	11.6

Semi-VOA's: ppm unless noted

1,2-Dibromoethane	<0.001
1,4 - Dioxane	<0.3
1-Methylnaphthalene	<0.01
2,4-Dimethylphenol	<0.01
2,4-Dinitrophenol	<0.05
2-Methylnaphthalene	<0.01
2-Methylphenol	<0.01
4-Methylphenol/3-Methylphenol	<0.01
4-Nitrophenol	<0.05
6-Methylchrysene	<0.01
7,12-Dimethylbenz(a)anthracene	<0.01
Benzo(a)anthracene	<0.01
Benzo(a)pyrene	<0.01
Benzo(b)fluoranthene	<0.01
Benzo(k)fluoranthene	<0.01
bis(2-ethylhexyl)Phthalate	0.009
Butyl Benzyl Phthalate	<0.01
Dibenz(a,h)acridine	<0.01
Dibenz(a,h)anthracene	<0.01
Dimethylphthalate	<0.01
Di-n-Butylphthalate	<0.01
Di-N-Octylphthalate	<0.01
Indene	<0.01
Phenanthrene	<0.01
Pyrene	<0.01
Pyridine	<0.02
Quinoline	<0.01
Thiophenol	<0.02
Anthracene	<0.01
Chrysene	<0.01

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	DH-24
Water	SAMPLE DATE	5/10/2001
	SAMPLE TIME	15:20
	LAB	TSC-SLC
	LAB NUMBER	L010691022
	SAMPLE NUMBER	EHC-0105-127
	TYPE	Groundwater
	GROUP	RI
	DESCRIPTION	
	REMARKS	

Semi-VOA's: ppm unless noted

Diethylphthalate	<0.01
Fluoranthene	<0.01
Naphthalene	<0.01
Phenol	<0.01

VOA's: ppm unless noted

1,2-Dichlorobenzene	<0.01
1,3-Dichlorobenzene	<0.01
1,4-Dichlorobenzene	<0.01
1,2-Dichloroethane	<0.001
2-Butanone	<0.02
Benzene	<0.001
Carbon Disulfide	<0.001
Chlorobenzene	<0.001
Chloroform	<0.001
Ethylbenzene	<0.001
m,p - Xylene	<0.001
o-Xylene	<0.001
Styrene	<0.001
Toluene	<0.001
Total Xylene	<0.001

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	DH-24	DH-24	DH-24	DH-24	DH-24	DH-24
Water	SAMPLE DATE	11/9/2001	11/20/2001	12/7/2001	12/19/2001	1/10/2002	1/23/2002
	SAMPLE TIME	11:20	00:00	10:55	11:00	12:55	13:35
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L011563018	L011587002	L011626001	L011661001	L020024002	L020042012
	SAMPLE NUMBER	EHC-0111-126	EHST-0111-201	EHST-0112-200	EHST-0112-400	EHST-0201-110	EHST-0201-311
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						
Common Ions: ppm unless noted							
Bicarbonate (HCO3)		62	56	48	156	49	21
Calcium (Ca) (DIS)		49					
Carbonate As CO3		<1	<1	<1	<1	<1	<1
Chloride (Cl)		69 J					
Magnesium (Mg) (DIS)		20					
Potassium (K) (DIS)		14					
Sodium (Na) (DIS)		121					
Sulfate (SO4)		355	201	206	406	380	554
Total Alkalinity As CaCO3		51	46	39	128	40	17
Hydrocarbon: ppm unless noted							
Diesel Range Organics		<0.5					
Diesel Range Organics as Diesel		<0.5					
Gasoline Range Organics		<0.02					
Gasoline Range Organics as Gasoline		<0.02					
Total Extractable Hydrocarbons		<0.5					
Total Purgeable Hydrocarbons		<0.02 J					
Metals: ppm unless noted							
Aluminum (Al) (DIS)		0.6					
Arsenic (As) (DIS)		17	16	18	12	6.7	5.3
Arsenic +3		13	16	11	6.5	3.2	1.8
Arsenic +5		3	1	7	5.5	3.5	3.6
Cadmium (Cd) (DIS)		0.1		0.1	0.1	0.2	0.2
Copper (Cu) (DIS)		0.05 J					
Iron (Fe) (DIS)		6.1		8.8	8.6	8.3	8.8
Lead (Pb) (DIS)		0.06 J		<0.005	<0.005	<0.005	0.005
Manganese (Mn) (DIS)		6.2		7.6	7.9	7.9	8.6
Zinc (Zn) (DIS)		3.6		4.3	4.5	4.7	5.2
Other: ppm unless noted							
Oxidation Reduction Potential		57.9					
Silicon+Silica (Si+SiO2)		38					
Physical/Fld-Lab: ppm unless noted							
Iron (Fe) (Fld)			6.4				
Iron (Fe+2) (Fld)			6.3				
Oxygen (O) (DIS) (Fld)		0.6	0.2	0.6	0.5	0.4	0.4
pH		6.8					
Depth To Water Level (ft)		27.04	27.4	28.1	28.5	29.06	29.4
Eh (millivolts)		312					
pH (Fld)		6.7	5.8	5.9	5.9	6.02	5.6
SC (umhos/cm at 25 C) (Fld)		1054	1067	1166	1140	1194	1329
SC (umhos/cm at 25 C)		1019					

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	DH-24	DH-24	DH-24	DH-24	DH-24	DH-24
Water	SAMPLE DATE	11/9/2001	11/20/2001	12/7/2001	12/19/2001	1/10/2002	1/23/2002
	SAMPLE TIME	11:20	00:00	10:55	11:00	12:55	13:35
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L011563018	L011587002	L011626001	L011661001	L020024002	L020042012
	SAMPLE NUMBER	EHC-0111-126	EHST-0111-201	EHST-0112-200	EHST-0112-400	EHST-0201-110	EHST-0201-311
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						

Physical/Fid-Lab: ppm unless noted

Total Suspended Solids	18 J						
TDS (Measured at 180 C)	722 J						
Water Temperature (C) (Fid)	11.7	11.7	11.6	11.7	11.4	11.5	

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	DH-24	DH-24	DH-24	DH-24	DH-24	DH-24
Water	SAMPLE DATE	1/23/2002	2/5/2002	2/19/2002	4/19/2002	5/10/2002	6/1/2002
	SAMPLE TIME	13:45	11:15	11:30	12:45	14:00	10:45
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L020042013	L020075001	L020110001	L020278001	L020364001	L020412029
	SAMPLE NUMBER	EHST-0201-312	EHST-0202-400	EHST-0202-900	EHST-0204-100	EHST-0205-100	EHST-0205-131
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RJ	RJ	RJ	RJ	RJ	RJ
	DESCRIPTION						
	REMARKS	Field Duplicate					

Common Ions: ppm unless noted

Bicarbonate (HCO3)	21	24	40	32	35	35
Calcium (Ca) (DIS)						95
Carbonate As CO3	<1	<1	<1	<1	<1	<1
Chloride (Cl)						97
Magnesium (Mg) (DIS)						37
Potassium (K) (DIS)						18
Sodium (Na) (DIS)						193
Sulfate (SO4)	575	526	504	586	586 J	651
Total Alkalinity As CaCO3	17	20	33	26	29	29

Metals: ppm unless noted

Aluminum (Al) (DIS)						1.4
Arsenic (As) (DIS)	5.3	4.1	2	0.2	0.2	0.3
Arsenic +3	1.7	0.9	0.4	0.1	0.08	0.08
Arsenic +5	3.6	3.2	1.5	0.08	0.1	0.2
Cadmium (Cd) (DIS)	0.2	0.2	0.2	0.2	0.2	0.2
Copper (Cu) (DIS)			0.03			0.1
Iron (Fe) (DIS)	8.8	9.1	5.2	0.2	0.1	0.1
Lead (Pb) (DIS)	0.005	0.006	0.007	0.01	0.02	0.02
Manganese (Mn) (DIS)	8.6	9.9	10	11	11	13
Zinc (Zn) (DIS)	5.1	5.8	6.2	7.4	9	9

Other: ppm unless noted

Oxidation Reduction Potential						67.9
Silicon+Silica (Si+SiO2)						38

Physical/Fid-Lab: ppm unless noted

Oxygen (O) (DIS) (Fid)	0.3	0.4	0.7	0.8	1.01	0.4
pH			6.4			6
Depth To Water Level (R)		29.8	31.2	37.2	31.2	31.2
pH (Fid)	5.6	5.9	5.8	5.3	5.6	5.6
SC (umhos/cm at 25 C) (Fid)	1320	1337	1356	1584	1557	1650
SC (umhos/cm at 25 C)			1398			1639
Total Suspended Solids						2.5
TDS (Measured at 180 C)						1177
Water Temperature (C) (Fid)	11.5	11.6	11.7	11.6	11.7	11.3

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	DH-24	DH-24	DH-24	DH-24	DH-24	DH-24
Water	SAMPLE DATE	6/6/2002	8/8/2002	9/12/2002	9/26/2002	9/26/2002	11/18/2002
	SAMPLE TIME	12:45	11:45	16:45	14:25	14:25	11:45
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L020426001	L020638001	L020775001	L020829001	L020829009	L020959007
	SAMPLE NUMBER	EHST-0206-100	EHST-0208-100	EHST-0209-300	EHST-0209-600	EHST-0209-600A	EHC-0211-128
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						
Common Ions: ppm unless noted							
	Bicarbonate (HCO3)	31	46	44	41		39
	Calcium (Ca) (DIS)	88					72
	Carbonate As CO3	<1	<1	<1	<1		<1
	Chloride (Cl)	105					110
	Magnesium (Mg) (DIS)	38					29
	Potassium (K) (DIS)	18					15
	Sodium (Na) (DIS)	184					161
	Sulfate (SO4)	691	746	536	794		650
	Total Alkalinity As CaCO3	25	38	36	34		32
Metals: ppm unless noted							
	Aluminum (Al) (DIS)	1.4					1.3 J
	Arsenic (As) (DIS)	0.2	1.1	1.6	0.08	1.2	2.2 J
	Arsenic +3	0.09	0.5	1.1	0.06		0.9
	Arsenic +5	0.1	0.8	0.3	0.03		0.5
	Cadmium (Cd) (DIS)	0.2					0.2
	Copper (Cu) (DIS)	0.1					0.08 UJ
	Iron (Fe) (DIS)	0.09	0.04	0.03	0.07	0.03	0.03
	Lead (Pb) (DIS)	0.009					0.009
	Manganese (Mn) (DIS)	13					9.6 J
	Zinc (Zn) (DIS)	8.9					8.4
Other: ppm unless noted							
	Silicon+Silica (Si+SiO2)	36					37
Physical/Fld-Lab: ppm unless noted							
	Oxygen (O) (DIS) (Fld)	0.4	2.8	1.5	1.7		0.9
	pH	6.2					6.9
	Depth To Water Level (ft)	31.9	25.9	25.9	26.1		27.9
	pH (Fld)	5.5	6	5.3	5.7		5.9
	SC (umhos/cm at 25 C) (Fld)	1675	1305	1289	1181		1380
	SC (umhos/cm at 25 C)	1639					1621
	Total Suspended Solids	7.4					1.6
	TDS (Measured at 180 C)	1185					1171
	Salinity (G/KG) (Fld)						0.6
	Turbidity (NTU) (Fld)						2
	Water Temperature (C) (Fld)	12.7	11.2	11.8	11.5		11.7

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	DH-24	DH-24	DH-24	DH-24	DH-24	DH-24
Water	SAMPLE DATE	11/18/2002	12/17/2002	12/17/2002	1/14/2003	6/2/2003	6/2/2003
	SAMPLE TIME	12:00	11:25	11:25	10:15	13:15	13:25
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L020959008	L021034001	L021034-001	L030016-001	L030245010	L030245011
	SAMPLE NUMBER	EHC-0211-250	EHST-0212-100	EHST-0212-100	EHST-0212-100	AEH-0306-172	AEH-0306-173
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS	Field Duplicate					Field Duplicate
Common Ions: ppm unless noted							
	Bicarbonate (HCO3)	39	37	30	36	74	72
	Calcium (Ca) (DIS)	85				65	65
	Carbonate As CO3	<1	<2	<2	<2	<2	<2
	Chloride (Cl)	103				101	93
	Magnesium (Mg) (DIS)	34				29	29
	Potassium (K) (DIS)	16				15	17
	Sodium (Na) (DIS)	180				195	194
	Sulfate (SO4)	645	607	607	602	587	598
	Total Alkalinity As CaCO3	32	30	30	36	61	59
Metals: ppm unless noted							
	Aluminum (Al) (DIS)	1.6 J					
	Arsenic (As) (DIS)	1.3 J	1.1	1.1	1.5	9.2	9.6
	Arsenic +3	0.8	1	0.98	1.5	6	6.9
	Arsenic +5	0.5	0.2	0.22	<0.005	3.5	2.9
	Cadmium (Cd) (DIS)	0.2				0.2	0.2
	Copper (Cu) (DIS)	0.07 UJ				0.03 J	0.02 J
	Iron (Fe) (DIS)	0.04	0.03	0.027	0.68	3.4	3.4
	Lead (Pb) (DIS)	0.01				0.005	0.005
	Manganese (Mn) (DIS)	12 J				9.4	9.3
	Zinc (Zn) (DIS)	10				6.9	6.9
Other: ppm unless noted							
	Silicon+Silica (Si+SiO2)	37					
Physical/Fld-Lab: ppm unless noted							
	Oxygen (O) (DIS) (Fld)		0.4	0.36	0.4	0.6	
	pH	6.3				6.6	6.6
	Depth To Water Level (ft)		28.7	28.69	29.34	28.5	
	pH (Fld)		5.7	6.67	5.43	5.6	
	SC (umhos/cm at 25 C) (Fld)		1508	1508	1676	1560	
	SC (umhos/cm at 25 C)	1596				1595	1615
	Total Suspended Solids	1.8				13	14
	TDS (Measured at 180 C)	1159				1116	1175
	Salinity (G/KG) (Fld)					0.7	
	Turbidity (NTU) (Fld)					1	
	Water Temperature (C) (Fld)		11.4	11.4	11.7	11.5	

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	DH-24	DH-24	DH-50	DH-50	DH-50
Water	SAMPLE DATE	10/29/2003	5/20/2004	4/25/2000	5/18/2000	5/18/2000
	SAMPLE TIME	13:45	13:30	15:15	12:45	13:00
	LAB	TSC-SLC	ELI	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L030605004	H04050133-012	L000630001	L000759008	L000759009
	SAMPLE NUMBER	AEH-0310-425	AEH-0405-135	IMMW-0004-120	EHST-0005-117	EHST-0005-118
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI
	DESCRIPTION					
	REMARKS					Field Duplicate

Common Ions: ppm unless noted

Bicarbonate (HCO3)	83	339
Calcium (Ca) (DIS)	79	126
Carbonate As CO3	<2	<1
Chloride (Cl)	93	138
Magnesium (Mg) (DIS)	33	35
Potassium (K) (DIS)	17	14
Sodium (Na) (DIS)	218	408
Sulfate (SO4)	633	874
Total Alkalinity As CaCO3	68	278

Common Ions (mg/L): ppm unless noted

Bicarbonate (HCO3)	130
Calcium (Ca) (DIS)	83
Chloride (Cl)	110
Magnesium (Mg) (DIS)	34
Potassium (K) (DIS)	20
Sodium (Na) (DIS)	280
Sulfate (SO4)	820
Total Alkalinity As CaCO3	110

Metals: ppm unless noted

Arsenic (As) (DIS)	17	11	12	12
Arsenic +3	8	1.4		
Arsenic +5	7.4	9.1		
Cadmium (Cd) (DIS)	0.2	0.002	<0.001	<0.001
Copper (Cu) (DIS)	0.1	0.01		
Iron (Fe) (DIS)	8.6	1.2	<0.05	<0.05
Lead (Pb) (DIS)	0.2	<0.005	<0.005	<0.005
Manganese (Mn) (DIS)	11	2.6	2.2	2.3
Zinc (Zn) (DIS)	6	0.3	0.5	0.5

Metals (mg/L): ppm unless noted

Arsenic (As) (DIS)	22.7
Arsenic +3	<0.03 J
Arsenic +5	19 J
Cadmium (Cd) (DIS)	0.145
Copper (Cu) (DIS)	0.017
Iron (Fe) (DIS)	10.79
Lead (Pb) (DIS)	<0.005
Manganese (Mn) (DIS)	12.05
Zinc (Zn) (DIS)	5.27

Physical/Fld-Lab: ppm unless noted

Iron (Fe) (Fld)	0.01
Iron (Fe+2) (Fld)	0.01

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	DH-24	DH-24	DH-50	DH-50	DH-50
Water	SAMPLE DATE	10/29/2003	5/20/2004	4/25/2000	5/18/2000	5/18/2000
	SAMPLE TIME	13:45	13:30	15:15	12:45	13:00
	LAB	TSC-SLC	ASARCO	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L030605004	H04050133-012	L000630001	L000759008	L000759009
	SAMPLE NUMBER	AEH-0310-425	AEH-0405-135	IMMW-0004-120	EHST-0005-117	EHST-0005-118
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI
	DESCRIPTION					
	REMARKS					Field Duplicate
Physical/Fld-Lab: ppm unless noted						
Oxygen (O) (DIS) (Fld)		0.36		5.6	1	1
Oxygen (O) (DIS) (Fld) (DIS)			0.14			
pH		7	6.3	6.8		
Depth To Water Level (ft)		27.23	29.06	33.7	33.7	
Eh (millivolts)				453	331	329
pH (Fld)		5.45	5.52	6.8	6.8	6.8
SC (umhos/cm at 25 C) (Fld)		1700	2100	2550	2540	2540
SC (umhos/cm at 25 C)		1707	2100	2390		
Total Suspended Solids		124	68			
TDS (Measured at 180 C)		1235	1440	1688		
Salinity (G/KG) (Fld)		0.7	0.9			
Turbidity (NTU) (Fld)		9	10	186.3		
Water Temperature (C) (Fld)		11.4	12.6	12.5	13.9	13.9

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	DH-50	DH-50	DH-50	DH-50	DH-50	DH-50
Water	SAMPLE DATE	5/30/2000	6/6/2000	6/13/2000	6/21/2000	6/29/2000	7/13/2000
	SAMPLE TIME	10:15	09:30	10:00	10:45	09:45	09:40
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L000825001	L000882001	L000910001	L000964003	L001003001	L001116001
	SAMPLE NUMBER	EHST-0005-120	EHST-0006-100	EHST-0006-200	EHST-0006-302	EHST-0006-400	EHST-0007-100
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						
Common Ions: ppm unless noted							
	Bicarbonate (HCO3)				207		
	Calcium (Ca) (DIS)				113		
	Carbonate As CO3				<1		
	Chloride (Cl)				162		
	Magnesium (Mg) (DIS)				31		
	Potassium (K) (DIS)				11		
	Sodium (Na) (DIS)				382		
	Sulfate (SO4)				836		
Metals: ppm unless noted							
	Arsenic (As) (DIS)	12	11	11	11	9.1	7.8
	Arsenic +3		1.5 J		1.2	0.4	0.01 UJ
	Arsenic +5		12		10	8.2	7.5
	Cadmium (Cd) (DIS)	<0.001	<0.001	<0.001	<0.001		
	Iron (Fe) (DIS)	<0.02	<0.05	<0.02	<0.03		
	Lead (Pb) (DIS)	<0.005	<0.005 J	<0.005	<0.005		
	Manganese (Mn) (DIS)	2.2	2.2	2.1	2		
	Zinc (Zn) (DIS)	0.5	0.5	0.5	0.4		
Physical/Fld-Lab: ppm unless noted							
	Iron (Fe) (Fld)	0.0	<0.01	0.02	<0.01	<0.01	<0.01
	Iron (Fe+2) (Fld)	0.0	<0.01	<0.01	<0.01	<0.01	<0.01
	Oxygen (O) (DIS) (Fld)	1.3	0.7	0.9	1.5	2.1	3.8
	pH				7.3		
	Depth To Water Level (ft)	33.6	33.4	33.1	32.6	32.4	32.3
	Eh (millivolts)	367	413	435	436	408	401
	pH (Fld)	6.5	6.4	6.4	6.5	6.5	6.5
	SC (umhos/cm at 25 C) (Fld)	2690	2620	2820	2510	2610	2410
	SC (umhos/cm at 25 C)				2500		
	Water Temperature (C) (Fld)	12.4	13.3	12.5	13.3	14.5	13.9

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	DH-50	DH-50	DH-50	DH-50	DH-50	DH-50
Water	SAMPLE DATE	7/24/2000	8/3/2000	8/16/2000	8/31/2000	9/13/2000	10/3/2000
	SAMPLE TIME	11:45	09:00	10:15	10:00	11:10	10:50
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L001190001	L001239002	L001333002	L001441002	L001513002	L001649002
	SAMPLE NUMBER	EHST-0007-200	EHST-0008-101	EHST-0008-201	EHST-0008-301	EHST-0009-101	EHST-0010-101
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						

Common Ions: ppm unless noted

Bicarbonate (HCO3)	92
Calcium (Ca) (DIS)	107
Carbonate As CO3	<1
Chloride (Cl)	150
Magnesium (Mg) (DIS)	27
Potassium (K) (DIS)	10
Sodium (Na) (DIS)	340
Sulfate (SO4)	908 J

Metals: ppm unless noted

Arsenic (As) (DIS)	7.6	7.8	7.8	8.5	12	14
Arsenic +3	0.009 U	0.02 U	<0.02	0.08 U	<0.02	<0.02
Arsenic +5	7.6	8.7 J	7.9	8.6	11	13
Cadmium (Cd) (DIS)		<0.001				
Iron (Fe) (DIS)		0.04 U				
Lead (Pb) (DIS)		<0.005				
Manganese (Mn) (DIS)		0.7				
Zinc (Zn) (DIS)		0.2				

Physical/Fld-Lab: ppm unless noted

Iron (Fe) (FId)	0.02		0.01	0.01		0.01
Iron (Fe+2) (FId)	<0.01	<0.01	0.01	<0.01		0.03
Oxygen (O) (DIS) (FId)	3.2	3.4	2.8	2.2	2	0.8
pH		7.2				
Depth To Water Level (ft)	32.4	32.3	32.5	32.8	33.1	33.6
Eh (millivolts)	390	412	433	333	379	
pH (FId)	6.5	6.8	6.4	6.9	7.2	6.4
SC (umhos/cm at 25 C) (FId)	2440	2450	2040	2360	2500	2260
SC (umhos/cm at 25 C)		2330				
Water Temperature (C) (FId)	14.1	13.2	13.6	12.9	13	12.3

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	DH-50	DH-50	DH-50	DH-50	DH-50	DH-50
Water	SAMPLE DATE	11/3/2000	11/15/2000	12/20/2000	2/7/2001	2/7/2001	5/1/2001
	SAMPLE TIME	12:05	11:10	10:50	11:25	11:35	14:30
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L001861003	L001922019	L002044003	L010183005	L010183006	L010608017
	SAMPLE NUMBER	EHST-0011-102	IMMW-0011-120	EHST-0012-102	EHST-0102-104	EHST-0102-105	EHC-0105-155
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS					Field Duplicate	
Common Ions: ppm unless noted							
	Bicarbonate (HCO3)		226	244			237
	Calcium (Ca) (DIS)		104	97			93
	Carbonate As CO3		<1	<1			<1
	Chloride (Cl)		101	189			199
	Magnesium (Mg) (DIS)		26	25			24
	Potassium (K) (DIS)		12	12			13
	Sodium (Na) (DIS)		456	492			434
	Sulfate (SO4)		885	1014			973
	Total Alkalinity As CaCO3		185	200			194
Metals: ppm unless noted							
	Aluminum (Al) (DIS)		<0.03				0.07
	Arsenic (As) (DIS)	15	14	15	16	17	17
	Arsenic +3	0.2	0.03	0.07 U	<0.02	<0.02	19
	Arsenic +5	52 R	14	15	16	16	<0.005
	Cadmium (Cd) (DIS)		0.001	0.001			<0.001
	Copper (Cu) (DIS)		0.02	0.008			0.03
	Iron (Fe) (DIS)		<0.02 J	0.1	<0.1	<0.1	<0.05
	Lead (Pb) (DIS)		0.008	<0.005			<0.005
	Manganese (Mn) (DIS)		1.4	1.3			0.8
	Zinc (Zn) (DIS)		0.3	0.3			0.3
Other: ppm unless noted							
	Benzo(j)Fluoranthene						<0.01
	Silicon+Silica (Si+SiO2)		25				23
Physical/Fld-Lab: ppm unless noted							
	Iron (Fe) (Fld)	<0.01					
	Iron (Fe+2) (Fld)			0.01			
	Oxygen (O) (DIS) (Fld)	0.7	1	1.2	1.2		2.09
	pH		7.2	7.6			8
	Depth To Water Level (ft)	33.1	33.2	34.05	34.8		34.7
	Eh (millivolts)	382	74.1	421	323		394
	pH (Fld)	6.8	6.9	6.9	7.01		6.9
	SC (umhos/cm at 25 C) (Fld)	2580	1928	2890	2450		2280
	SC (umhos/cm at 25 C)		2660	2720			2730
	Total Suspended Solids						85
	TDS (Measured at 180 C)		1966	1930			1990
	Water Temperature (C) (Fld)	12.5	11.4	12.5	12.2		12.3
Semi-VOA's: ppm unless noted							
	1,2-Dibromoethane						<0.001
	1,4 - Dioxane						<0.3
	1-Methylnaphthalene						<0.01
	2,4-Dimethylphenol						<0.01 J

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	DH-50
Water	SAMPLE DATE	5/1/2001
	SAMPLE TIME	14:30
	LAB	TSC-SLC
	LAB NUMBER	L010608017
	SAMPLE NUMBER	EHC-0105-155
	TYPE	Groundwater
	GROUP	RI
	DESCRIPTION	
	REMARKS	

Semi-VOA's: ppm unless noted

2,4-Dinitrophenol	<0.06
2-Methylnaphthalene	<0.01
2-Methylphenol	<0.01 J
4-Methylphenol/3-Methylphenol	<0.01 J
4-Nitrophenol	<0.06
6-Methylchrysene	<0.01
7,12-Dimethylbenz(a)anthracene	<0.01
Benzo(a)anthracene	<0.01
Benzo(a)pyrene	<0.01
Benzo(b)fluoranthene	<0.01
Benzo(k)fluoranthene	<0.01
bis(2-ethylhexyl) Phthalate	<0.01
Butyl Benzyl Phthalate	<0.01
Dibenz(a,h)acridine	<0.01
Dibenz(a,h)anthracene	<0.01
Dimethylphthalate	<0.01
Di-n-Butylphthalate	<0.01
Di-N-Octylphthalate	<0.01
Indene	<0.01
Phenanthrene	<0.01
Pyrene	<0.01
Pyridine	<0.02
Quinoline	<0.01
Thiophenol	<0.02
Anthracene	<0.01
Chrysene	<0.01
Diethylphthalate	<0.01
Fluoranthene	<0.01
Naphthalene	<0.01
Phenol	<0.01 J

VOA's: ppm unless noted

1,2-Dichlorobenzene	<0.01
1,3-Dichlorobenzene	<0.01
1,4-Dichlorobenzene	<0.01
1,2-Dichloroethane	<0.001
2-Butanone	<0.01
Benzene	<0.001
Carbon Disulfide	<0.001

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	DH-50
Water	SAMPLE DATE	5/1/2001
	SAMPLE TIME	14:30
	LAB	TSC-SLC
	LAB NUMBER	L010608017
	SAMPLE NUMBER	EHC-0105-155
	TYPE	Groundwater
	GROUP	RI
	DESCRIPTION	
	REMARKS	

VOA's: ppm unless noted

Chlorobenzene	<0.001
Chloroform	<0.001
Ethylbenzene	<0.001
m,p - Xylene	<0.001
o-Xylene	<0.001
Styrene	<0.001 J
Toluene	<0.001
Total Xylene	<0.001

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	DH-50	DH-50	DH-50	DH-50	DH-50	DH-50
Water	SAMPLE DATE	9/26/2001	10/19/2001	11/2/2001	11/8/2001	11/20/2001	12/7/2001
	SAMPLE TIME	09:35	11:50	10:07	09:40	00:00	11:45
	LAB	TSC-SLC	HYDRO	HYDRO	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L011367001	FIELD ONLY	FIELD ONLY	L011535018	L011587003	L011626003
	SAMPLE NUMBER	EHST-0109-100	EHST-0110-110	EHST-0111-111	EHC-0111-153	EHST-0111-202	EHST-0112-202
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						
Common Ions: ppm unless noted							
	Bicarbonate (HCO3)	183			145	142	120
	Calcium (Ca) (DIS)				90		
	Carbonate As CO3	<1			<1	<1	<1
	Chloride (Cl)				103		
	Magnesium (Mg) (DIS)				23		
	Potassium (K) (DIS)				10		
	Sodium (Na) (DIS)				320		
	Sulfate (SO4)	727			669 J	542	475
	Total Alkalinity As CaCO3	150			119	116	98
Metals: ppm unless noted							
	Aluminum (Al) (DIS)				<0.05		
	Arsenic (As) (DIS)	10			8.8	12	11
	Arsenic +3	4.3			4.9	7	5.4
	Arsenic +5	5.7			4.5	5	6.6
	Cadmium (Cd) (DIS)	<0.001			<0.001		<0.001
	Copper (Cu) (DIS)				<0.004		
	Iron (Fe) (DIS)	<0.02			<0.02		<0.02
	Lead (Pb) (DIS)	0.007			<0.005		<0.005
	Manganese (Mn) (DIS)	0.4			0.2		0.3
	Zinc (Zn) (DIS)	0.1			0.09		0.1
Other: ppm unless noted							
	Oxidation Reduction Potential				182.2		
	Silicon+Silica (Si+SiO2)				24		
Physical/Fld-Lab: ppm unless noted							
	Iron (Fe) (Fld)	<0.01	<0.01	<0.01		<0.01	
	Iron (Fe+2) (Fld)	<0.01	<0.01	<0.01		<0.01	
	Oxygen (O) (DIS) (Fld)	2.7	2	1.8	2.5	1.6	2.5
	pH				7.6		
	Depth To Water Level (ft)	30.6	31.3	31.6	31.6	32.1	32.7
	Eh (millivolts)	347	411		434		
	pH (Fld)	6.8	6.9	6.7	7.4	6.6	6.9
	SC (umhos/cm at 25 C) (Fld)	2000	2030	1856	1796	2070	2180
	SC (umhos/cm at 25 C)				1849		
	Total Suspended Solids				<1		
	TDS (Measured at 180 C)				1323		
	Water Temperature (C) (Fld)	12.5	12.5	12.6	12.3	12.9	12.7

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	DH-50	DH-50	DH-50	DH-50	DH-50	DH-50
Water	SAMPLE DATE	12/14/2001	12/19/2001	12/27/2001	1/11/2002	1/16/2002	1/23/2002
	SAMPLE TIME	10:45	11:40	12:30	10:40	10:45	13:00
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L011652001	L011661003	L011677001	L020024003	L020027001	L020042010
	SAMPLE NUMBER	EHST-0112-300	EHST-0112-402	EHST-0112-500	EHST-0201-111	EHST-0201-200	EHST-0201-309
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						
Common Ions: ppm unless noted							
	Bicarbonate (HCO3)	134	129	134	146	165	142
	Carbonate As CO3	<1	<1	<1	<1	<1	<1
	Sulfate (SO4)	814	777	871	764	813	828
	Total Alkalinity As CaCO3	110	106	110	120	135	116
Metals: ppm unless noted							
	Arsenic (As) (DIS)	15	16	15	15	16	16
	Arsenic +3		6.8		5.8		4.6
	Arsenic +5		9.2		10		11
	Cadmium (Cd) (DIS)		<0.001		0.002		<0.001
	Iron (Fe) (DIS)	0.04	<0.02	<0.02	<0.02	<0.02	<0.02
	Lead (Pb) (DIS)		<0.005		<0.005		<0.005
	Manganese (Mn) (DIS)		0.5		0.6		0.7
	Zinc (Zn) (DIS)		0.2		0.2		0.2
Physical/Fld-Lab: ppm unless noted							
	Iron (Fe+2) (Fld)	<0.01					
	Oxygen (O) (DIS) (Fld)	0.6	0.4	0.4	0.4	0.5	0.6
	Depth To Water Level (ft)	32.8	33	35.2	33.6	33.7	33.9
	pH (Fld)	6.8	6.7	6.8	6.7	6.6	6.5
	SC (umhos/cm at 25 C) (Fld)	2380	2350	2400	2440	2430	2420
	Water Temperature (C) (Fld)	12.4	12.7	12.4	12.7	12.5	12.5

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	DH-50	DH-50	DH-50	DH-50	DH-50	DH-50
Water	SAMPLE DATE	2/5/2002	2/19/2002	2/27/2002	5/10/2002	5/30/2002	8/8/2002
	SAMPLE TIME	13:15	13:30	11:35	00:00	12:10	16:30
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	ASARCO	TSC-SLC	TSC-SLC
	LAB NUMBER	L020075003	L020110003	L020142004	205111	L020398002	L020642002
	SAMPLE NUMBER	EHST-0202-402	EHST-0202-902	EHST-0202-203	EHST-0205-111	EHC-0205-158	EHST-0208-109
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						
Common Ions: ppm unless noted							
	Bicarbonate (HCO3)	149	159	166		139	92
	Calcium (Ca) (DIS)					88	
	Carbonate As CO3	<1	<1	<1		<1	<1
	Chloride (Cl)					212	
	Magnesium (Mg) (DIS)					21	
	Potassium (K) (DIS)					12	
	Sodium (Na) (DIS)					587	
	Sulfate (SO4)	932	911	876		996	581
	Total Alkalinity As CaCO3	122	130	136		114	75
Metals: ppm unless noted							
	Aluminum (Al) (DIS)					<0.05	
	Arsenic (As) (DIS)	17	17	17		18	8.6
	Arsenic +3	5.2	5.2			2.4	6.3
	Arsenic +5	12	12			17	2.2
	Cadmium (Cd) (DIS)	<0.001	<0.001			0.003	
	Copper (Cu) (DIS)		0.01			0.008	
	Iron (Fe) (DIS)	<0.02	0.08	<0.02		<0.02	<0.02
	Lead (Pb) (DIS)	<0.005	<0.005			<0.005	
	Manganese (Mn) (DIS)	0.7	0.8			0.2	
	Zinc (Zn) (DIS)	0.2	0.2			0.2	
Other: ppm unless noted							
	Oxidation Reduction Potential					18.5	
	Silicon+Silica (Si+SiO2)					27	
Physical/Fid-Lab: ppm unless noted							
	Oxygen (O) (DIS) (Fid)	1.1	1.6	0.9		2.5	7.7
	pH		7.3			6.9	
	Depth To Water Level (ft)	34.3	34.7	34.9	35.6	35.6	30.5
	pH (Fid)	6.7	7	6.7		6.8	7.2
	SC (umhos/cm at 25 C) (Fid)	2430	2540	2510		2600	1587
	SC (umhos/cm at 25 C)		2530			2610	
	Total Suspended Solids					2.5 J	
	TDS (Measured at 180 C)					1890	
	Water Temperature (C) (Fid)	12.4	12.5	11.9		12.2	12

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	DH-50	DH-50	DH-50	DH-50	DH-50
Water	SAMPLE DATE	9/26/2002	11/13/2002	6/2/2003	10/29/2003	5/20/2004
	SAMPLE TIME	15:25	12:30	09:30	14:50	10:00
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	ELI
	LAB NUMBER	L020829003	L020943008	L030245002	L030605008	H04050133-002
	SAMPLE NUMBER	EHST-0209-602	EHC-0211-156	AEH-0306-164	AEH-0310-430	AEH-0405-125
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI
	DESCRIPTION					
	REMARKS					
Common Ions: ppm unless noted						
	Bicarbonate (HCO3)	92	92	188	151	
	Calcium (Ca) (DIS)		104	76	83	
	Carbonate As CO3	<1	<1	<2	<2	
	Chloride (Cl)		135	132	93	
	Magnesium (Mg) (DIS)		26	21	21	
	Potassium (K) (DIS)		11	15	11	
	Sodium (Na) (DIS)		309	361	258	
	Sulfate (SO4)	609	704	781	580	
	Total Alkalinity As CaCO3	75	75	154	124	
Common Ions (mg/L): ppm unless noted						
	Bicarbonate (HCO3)					200
	Calcium (Ca) (DIS)					91
	Chloride (Cl)					99
	Magnesium (Mg) (DIS)					22
	Potassium (K) (DIS)					13
	Sodium (Na) (DIS)					328
	Sulfate (SO4)					770
	Total Alkalinity As CaCO3					160
Metals: ppm unless noted						
	Aluminum (Al) (DIS)		<0.05			
	Arsenic (As) (DIS)	8.9	7.7	14	8.2	
	Arsenic +3	9.9	4.2	15	0.4	
	Arsenic +5	<0.005	3.2	<0.005	7.6	
	Cadmium (Cd) (DIS)		<0.001	<0.001	<0.001	
	Copper (Cu) (DIS)		0.006	0.007 J	0.006	
	Iron (Fe) (DIS)	<0.02	<0.02	<0.02	<0.03	
	Lead (Pb) (DIS)		<0.005	<0.005	<0.005	
	Manganese (Mn) (DIS)		<0.02	<0.02	<0.02	
	Zinc (Zn) (DIS)		0.05	0.1	0.06	
Metals (mg/L): ppm unless noted						
	Arsenic (As) (DIS)					8.705
	Arsenic +3					<0.006 J
	Arsenic +5					14 J
	Cadmium (Cd) (DIS)					<0.001
	Copper (Cu) (DIS)					0.004
	Iron (Fe) (DIS)					0.41
	Lead (Pb) (DIS)					<0.005
	Manganese (Mn) (DIS)					0.01
	Zinc (Zn) (DIS)					0.16
Other: ppm unless noted						
	Silicon+Silica (Si+SiO2)		21			

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	DH-50	DH-50	DH-50	DH-50	DH-50
Water	SAMPLE DATE	9/26/2002	11/13/2002	6/2/2003	10/29/2003	5/20/2004
	SAMPLE TIME	15:25	12:30	09:30	14:50	10:00
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	ASARCO
	LAB NUMBER	L020829003	L020943008	L030245002	L030605008	H04050133-002
	SAMPLE NUMBER	EHST-0209-602	EHC-0211-156	AEH-0306-164	AEH-0310-430	AEH-0405-125
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI
	DESCRIPTION					
	REMARKS					

Physical/Fld-Lab: ppm unless noted						
Oxygen (O) (DIS) (Fld)	4.6	3.9	2.6	5.71		
Oxygen (O) (DIS) (Fld) (DIS)					0.27	
pH		7.2	7.3	7.8	7.2	
Depth To Water Level (ft)	30.7	32.04	32.5	31.9	33.51	
pH (Fld)	6.7	6.1	6.5	6.45	6.28	
SC (umhos/cm at 25 C) (Fld)	1769	1852	2150	1690	2110	
SC (umhos/cm at 25 C)		1973	2220	1769	2260	
Total Suspended Solids		1.6	5.7	9.9	<10	
TDS (Measured at 180 C)		1402	1536	1224	1440	
Salinity (G/KG) (Fld)			1	0.7	1	
Turbidity (NTU) (Fld)			9	7	0.0	
Water Temperature (C) (Fld)	12.1	12.4	11.6	12.1	12.4	

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	SPARGE 1	SPARGE 1	SPARGE 1	SPARGE 2	SPARGE 2
Water	SAMPLE DATE	6/2/2003	10/30/2003	5/13/2004	6/2/2003	10/30/2003
	SAMPLE TIME	00:00	00:00	13:15	00:00	00:00
	LAB	ASARCO	TSC-SLC	ASARCO	ASARCO	TSC-SLC
	LAB NUMBER	0306-226	AEH-0310-459	AEH-0405-241	0306-227	AEH-0310-460
	SAMPLE NUMBER	AEH-0306-226	AEH-0310-459	AEH-0405-241	AEH-0306-227	AEH-0310-460
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RJ	RJ	RJ	RJ	RJ
	DESCRIPTION		SWL Only Req	SWL Only Req		SWL Only Req
	REMARKS					

Physical/Fid-Lab: ppm unless noted

Depth To Water Level (ft)	33.5	32.5	34.04	33.8	32.75
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TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	SPARGE 2	SPARGE 3	SPARGE 3	SPARGE 3	SPARGE 3
Water	SAMPLE DATE	5/13/2004	5/30/2000	8/3/2000	8/3/2000	8/16/2000
	SAMPLE TIME	13:16	14:35	13:00	13:15	13:45
	LAB	ASARCO	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	AEH-0405-242	L000825010	L001239010	L001239011	L001333010
	SAMPLE NUMBER	AEH-0405-242	EHST-0005-129	EHST-0008-109	EHST-0008-110	EHST-0008-209
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI
	DESCRIPTION	SWL Only Req				
	REMARKS				Field Duplicate	

Common Ions: ppm unless noted

Bicarbonate (HCO3)	59	49	54
Calcium (Ca) (DIS)	61	49	46
Carbonate As CO3	<1	<1	<1
Chloride (Cl)	49	36	36
Magnesium (Mg) (DIS)	24	19	19
Potassium (K) (DIS)	15	13	12
Sodium (Na) (DIS)	133	113	106
Sulfate (SO4)	411	579 J	445 J

Metals: ppm unless noted

Arsenic (As) (DIS)	25	25	25	19
Arsenic +3	22	21	23	17
Arsenic +5	1.4	0.9 J	1 J	1.4
Cadmium (Cd) (DIS)	0.1	0.1	0.1	
Iron (Fe) (DIS)	13	12	12	
Lead (Pb) (DIS)	<0.005	<0.005	<0.005	
Manganese (Mn) (DIS)	8.3	7	6.5	
Zinc (Zn) (DIS)	5.5	4.4	4.5	

Physical/Fld-Lab: ppm unless noted

Iron (Fe) (Fld)	0.0			4.6
Iron (Fe+2) (Fld)	0.0	11.8		4.2
Oxygen (O) (DIS) (Fld)	0.9	0.9	1	1.3
pH	5.9	6	6	
Depth To Water Level (ft)	34.32	33.05	31.8	33.2
Eh (millivolts)		240	255	275
pH (Fld)		6.05	6.2	6.9
SC (umhos/cm at 25 C) (Fld)		1150	1116	1123
SC (umhos/cm at 25 C)		1141	1080	1098
Water Temperature (C) (Fld)		13.3	13.8	13.8
				13.6

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	SPARGE 3	SPARGE 3	SPARGE 3	SPARGE 3	SPARGE 3	SPARGE 3
Water	SAMPLE DATE	8/31/2000	9/13/2000	9/22/2000	10/3/2000	10/17/2000	11/3/2000
	SAMPLE TIME	14:10	15:20	12:35	14:55	15:10	13:40
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L001441010	L001513011	L001585006	L001649012	L001753003	L001861006
	SAMPLE NUMBER	EHST-0008-309	EHST-0009-110	EHST-0009-205	EHST-0010-111	EHST-0010-202	EHST-0011-105
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						

Metals: ppm unless noted

Arsenic (As) (DIS)	22	3.9	2.8	3.7	2.2 J	4.1
Arsenic +3	21	0.3	<0.02	0.03	0.02	<0.005
Arsenic +5	0.7	3.8	2.9	3.8	2.5	4.2

Physical/Fid-Lab: ppm unless noted

Iron (Fe) (Fid)	8.8		<0.5	0.02		
Iron (Fe+2) (Fid)	8.6		<0.5	0.02	0.01	<0.01
Oxygen (O) (DIS) (Fid)	0.8	4.8	9.05	9.1	10.7	9.8
Depth To Water Level (ft)	33.5	34.2	34.3	34.4	36.4	34
Eh (millivolts)	244	409	396		304	375
pH (Fid)	6.4	6.7	6.3	6	6.5	6.2
SC (umhos/cm at 25 C) (Fid)	1050	945	969	866	966	931
Water Temperature (C) (Fid)	13	14.8	10.4	11.7	13.6	11

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	SPARGE 3	SPARGE 3	SPARGE 3	SPARGE 3	SPARGE 3	SPARGE 3
Water	SAMPLE DATE	11/3/2000	12/20/2000	12/20/2000	2/7/2001	5/14/2001	9/26/2001
	SAMPLE TIME	13:45	14:40	14:55	10:35	16:45	13:00
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L001861007	L002044010	L002044011	L010183003	L010699010	L011367011
	SAMPLE NUMBER	EHST-0011-106	EHST-0012-109	EHST-0012-110	EHST-0102-102	EHST-0105-195	EHST-0109-110
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS	Field Duplicate	Field Duplicate				

Common Ions: ppm unless noted

Bicarbonate (HCO3)		65	63		65	45
Calcium (Ca) (DIS)		37	37		51	
Carbonate As CO3		<1	<1			<1
Chloride (Cl)		30	32		65	
Magnesium (Mg) (DIS)		16	16		21	
Potassium (K) (DIS)		11	11		13	
Sodium (Na) (DIS)		115	117		135	
Sulfate (SO4)		355	373		489	390
Total Alkalinity As CaCO3		53	52		53	37

Metals: ppm unless noted

Aluminum (Al) (DIS)					0.6	
Arsenic (As) (DIS)	4.1	19	16	20	23	23
Arsenic +3	<0.005	2.7 R	15	17	23	20
Arsenic +5	4.2	0.5 R	1.6	1.6	<0.005	3
Cadmium (Cd) (DIS)		0.09	0.09		0.1	0.1
Copper (Cu) (DIS)		0.005	0.005		0.007	
Iron (Fe) (DIS)		1.1	1.1	2.7	8.3	10
Lead (Pb) (DIS)		<0.005	<0.005		<0.005	<0.005
Manganese (Mn) (DIS)		5.4	5.5		7.1	6.8
Zinc (Zn) (DIS)		3.5	3.6		3.8	3.9

Other: ppm unless noted

Silicon+Silica (Si+SiO2)					34	
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Physical/Fld-Lab: ppm unless noted

Iron (Fe) (Fld)						9.7
Iron (Fe+2) (Fld)			1			9.1
Oxygen (O) (DIS) (Fld)	9.8	1.4	1.4	1.01	0.8	0.1
pH		6.4	6.4		6.4	
Depth To Water Level (ft)			34.9	35.5	35.5	31.3
Eh (millivolts)	375	334	334	296	313	207
pH (Fld)	6.2	6.4	6.4	6.8	6.5	5.5
SC (umhos/cm at 25 C) (Fld)	931	1030	1030	920	909	1135
SC (umhos/cm at 25 C)		953	955		1170	
Total Suspended Solids					28	
TDS (Measured at 180 C)		658	660		822	
Water Temperature (C) (Fld)	11	10.8	10.8	11	13.7	11.7

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	SPARGE 3	SPARGE 3	SPARGE 3	SPARGE 3	SPARGE 3	SPARGE 3
Water	SAMPLE DATE	10/19/2001	11/2/2001	11/20/2001	12/7/2001	12/19/2001	1/10/2002
	SAMPLE TIME	15:20	09:26	00:00	11:30	11:20	12:40
	LAB	HYDRO	HYDRO	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	FIELD ONLY	FIELD ONLY	L011587001	L011626002	L011661002	L020024001
	SAMPLE NUMBER	EHST-0110-100	EHST-0111-100	EHST-0111-200	EHST-0112-201	EHST-0112-401	EHST-0201-109
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RJ	RJ	RJ	RJ	RJ	RJ
	DESCRIPTION						
	REMARKS						

Common Ions: ppm unless noted

Bicarbonate (HCO3)	26	24	61
Carbonate As CO3	<1	<1	<1
Sulfate (SO4)	257	464	457
Total Alkalinity As CaCO3	21	20	50

Metals: ppm unless noted

Arsenic (As) (DIS)	17	2.6	2.2	4.9
Arsenic +3	16	1	0.9	1.8
Arsenic +5	4	1.7	1.3	3
Cadmium (Cd) (DIS)		0.1	0.1	0.2
Iron (Fe) (DIS)		0.06	<0.02	0.03
Lead (Pb) (DIS)		<0.005	<0.005	<0.005
Manganese (Mn) (DIS)		8	8.4	10
Zinc (Zn) (DIS)		4.8	5.3	6.5

Physical/Fld-Lab: ppm unless noted

Iron (Fe) (Fld)	9	11	7.7			
Iron (Fe+2) (Fld)	8.7	7.4	7.6			
Oxygen (O) (DIS) (Fld)	0.1	0.03	0.2	8.3	9.2	5.7
Depth To Water Level (R)	31.8	32.3	32.7	33.4	33.8	34.3
Eh (millivolts)	250					
pH (Fld)	6	5.9	5.8	5.9	5.9	6.1
SC (umhos/cm at 25 C) (Fld)	1157	1159	1213	1261	1243	1171
Water Temperature (C) (Fld)	11.4	11.5	11.6	11.5	11.3	11.5

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	SPARGE 3	SPARGE 3	SPARGE 3	SPARGE 3	SPARGE 3	SPARGE 3
Water	SAMPLE DATE	1/23/2002	2/5/2002	2/19/2002	4/19/2002	5/10/2002	6/6/2002
	SAMPLE TIME	13:15	12:10	12:00	13:10	14:15	00:00
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	ASARCO
	LAB NUMBER	L020042011	L020075002	L020110002	L020278002	L020364002	206110
	SAMPLE NUMBER	EHST-0201-310	EHST-0202-401	EHST-0202-901	EHST-0204-101	EHST-0205-101	EHST-0206-110
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						

Common Ions: ppm unless noted

Bicarbonate (HCO3)	31	48	37	4.9	3.7
Carbonate As CO3	<1	<1	<1	<1	<1
Sulfate (SO4)	601	560	586	639	657 J
Total Alkalinity As CaCO3	25	39	30	4	3

Metals: ppm unless noted

Arsenic (As) (DIS)	3.4	3.6	4.2	4.8	3.5
Arsenic +3	1	1.1	1.5	1.4	0.7
Arsenic +5	2.2	2.6	2.8	3.2	2.8
Cadmium (Cd) (DIS)	0.2	0.2	0.2	0.2	0.3
Copper (Cu) (DIS)			0.01		
Iron (Fe) (DIS)	<0.02	<0.02	0.09	<0.02	0.03
Lead (Pb) (DIS)	<0.005	<0.005	<0.005	<0.005	<0.005
Manganese (Mn) (DIS)	9.9	11	11	12	13
Zinc (Zn) (DIS)	6	6.2	6.8	9.9	12

Physical/Fid-Lab: ppm unless noted

Oxygen (O) (DIS) (Fid)	8.6	9.6	8.4	8.5	1629
pH			6.5		
Depth To Water Level (ft)	34.7	35.05	35.5	36.6	36.5
pH (Fid)	6	6.8	7.2	6.03	5.5
SC (umhos/cm at 25 C) (Fid)	1459	1450	1457	1654	10.9
SC (umhos/cm at 25 C)			1540		
Water Temperature (C) (Fid)	11.2	10.5	11	12.1	11.1

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	SPARGE 3	SPARGE 3	SPARGE 3	SPARGE 3	SPARGE 3	SPARGE 3
Water	SAMPLE DATE	8/8/2002	9/26/2002	11/13/2002	12/17/2002	12/17/2002	6/2/2003
	SAMPLE TIME	12:00	15:05	14:50	11:45	11:45	12:45
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L020638002	L020829002	L020943010	L021034002	L021034-002	L030245009
	SAMPLE NUMBER	EHST-0208-101	EHST-0209-601	EHST-0211-211	EHST-0212-101	EHST-0212-101	AEH-0306-171
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						
Common Ions: ppm unless noted							
	Bicarbonate (HCO3)	3.7	1.2	7.3	3.7	3	88
	Calcium (Ca) (DIS)			107			81
	Carbonate As CO3	<1	<1	<1	<2	<2	<2
	Chloride (Cl)			148			132
	Magnesium (Mg) (DIS)			44			35
	Potassium (K) (DIS)			21			20
	Sodium (Na) (DIS)			236			262
	Sulfate (SO4)	831	821	823	837	837	705
	Total Alkalinity As CaCO3	3	1	6	3	3	72
Metals: ppm unless noted							
	Aluminum (Al) (DIS)			2.8			
	Arsenic (As) (DIS)	1.2	1	1.5	1.5	1.5	20
	Arsenic +3	0.3	0.5	0.5	1	0.98	16
	Arsenic +5	0.9	0.5	1	0.5	0.52	4
	Cadmium (Cd) (DIS)			0.2			0.2
	Copper (Cu) (DIS)			0.02			0.004 J
	Iron (Fe) (DIS)	<0.02	<0.02	<0.02	<0.02	<0.02	10
	Lead (Pb) (DIS)			<0.005			<0.005
	Manganese (Mn) (DIS)			15			11
	Zinc (Zn) (DIS)			12			7.3
Other: ppm unless noted							
	Silicon+Silica (Si+SiO2)			37			
Physical/Fld-Lab: ppm unless noted							
	Oxygen (O) (DIS) (Fld)	9.9	7.07	5.2	4.9	4.86	0.08
	pH			5.5			6.6
	Depth To Water Level (ft)	31.3	31.7	32.9	35.04	35.04	33.8
	pH (Fld)	4.8	4.7	5.4	5.4	5.35	5.9
	SC (umhos/cm at 25 C) (Fld)	1939	1801	1920	1767	1767	1940
	SC (umhos/cm at 25 C)			1968			1996
	Total Suspended Solids			<1			31
	TDS (Measured at 180 C)			1462			1424
	Salinity (G/KG) (Fld)						0.9
	Turbidity (NTU) (Fld)						1
	Water Temperature (C) (Fld)	11.3	11.7	11.5	10.9	10.9	11.8

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	SPARGE 3	SPARGE 3	STW-1	STW-1	STW-1
Water	SAMPLE DATE	10/30/2003	5/20/2004	5/10/2000	5/18/2000	5/30/2000
	SAMPLE TIME	08:00	13:00	12:00	10:40	14:00
	LAB	TSC-SLC	ELI	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L030605013	H04050133-011	L000720001	L000759001	L000825007
	SAMPLE NUMBER	AEH-0310-436	AEH-0405-134	EHST-0005-100	EHST-0005-110	EHST-0005-126
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI
	DESCRIPTION					
	REMARKS					

Common Ions: ppm unless noted

Bicarbonate (HCO3)	104	256
Calcium (Ca) (DIS)	86	68
Carbonate As CO3	<2	<1
Chloride (Cl)	110	229
Magnesium (Mg) (DIS)	36	16
Potassium (K) (DIS)	21	13
Sodium (Na) (DIS)	257	521
Sulfate (SO4)	712	921
Total Alkalinity As CaCO3	85	

Common Ions (mg/L): ppm unless noted

Bicarbonate (HCO3)	170
Calcium (Ca) (DIS)	81
Chloride (Cl)	130
Magnesium (Mg) (DIS)	32
Potassium (K) (DIS)	20
Sodium (Na) (DIS)	309
Sulfate (SO4)	750
Total Alkalinity As CaCO3	140

Metals: ppm unless noted

Arsenic (As) (DIS)	24	46	48	47
Arsenic +3	19	46		
Arsenic +5	5.4	3.8		
Cadmium (Cd) (DIS)	0.2	<0.001	0.001	<0.001
Copper (Cu) (DIS)	0.006			
Iron (Fe) (DIS)	15	0.1	0.2	0.2
Lead (Pb) (DIS)	<0.005	<0.005	<0.005	<0.005
Manganese (Mn) (DIS)	12	2.5	2.5	2.7
Zinc (Zn) (DIS)	6.1	0.2	0.2	0.2

Metals (mg/L): ppm unless noted

Arsenic (As) (DIS)	24.96
Arsenic +3	16 J
Arsenic +5	1.3 J
Cadmium (Cd) (DIS)	0.189
Copper (Cu) (DIS)	0.008
Iron (Fe) (DIS)	13.44
Lead (Pb) (DIS)	<0.005
Manganese (Mn) (DIS)	11.16
Zinc (Zn) (DIS)	5.21

Physical/Fld-Lab: ppm unless noted

Iron (Fe) (Fld)	0.2	0.2	0.2
Iron (Fe+2) (Fld)	<0.1	0.2	0.2

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB
ASARCO, East Helena Plant

Sample Matrix	STATION	SPARGE 3	SPARGE 3	STW-1	STW-1	STW-1
Water	SAMPLE DATE	10/30/2003	5/20/2004	5/10/2000	5/18/2000	5/30/2000
	SAMPLE TIME	08:00	13:00	12:00	10:40	14:00
	LAB	TSC-SLC	ASARCO	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L030605013	H04050133-011	L000720001	L000759001	L000825007
	SAMPLE NUMBER	AEH-0310-436	AEH-0405-134	EHST-0005-100	EHST-0005-110	EHST-0005-126
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI
	DESCRIPTION					
	REMARKS					
Physical/Fld-Lab: ppm unless noted						
Oxygen (O) (DIS) (Fld)		0.17		1.3	1.2	0.6
Oxygen (O) (DIS) (Fld) (DIS)			0.08			
pH		7	6.5	7.8		
Depth To Water Level (ft)		32.6	34.33	33.8	33.8	33.6
Eh (millivolts)				241	224	213
pH (Fld)		5.52	5.65	6.9	7	7.09
SC (umhos/cm at 25 C) (Fld)		1970	2190	2790	2940	2900
SC (umhos/cm at 25 C)		1986	2340	2890		
Total Suspended Solids		16 J	31			
TDS (Measured at 180 C)		1377	1500			
Salinity (G/KG) (Fld)		0.9	1			
Turbidity (NTU) (Fld)		2	10			
Water Temperature (C) (Fld)		11.4	12.5	12.7	13.6	13.5

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-1	STW-1	STW-1	STW-1	STW-1	STW-1
Water	SAMPLE DATE	5/30/2000	6/6/2000	6/13/2000	6/21/2000	6/29/2000	6/29/2000
	SAMPLE TIME	14:10	13:10	13:10	14:40	13:30	13:45
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L000825008	L000882009	L000910008	L000964009	L001003008	L001003009
	SAMPLE NUMBER	EHST-0005-127	EHST-0006-108	EHST-0006-207	EHST-0006-308	EHST-0006-407	EHST-0006-408
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS	Field Duplicate					Field Duplicate

Common Ions: ppm unless noted

Bicarbonate (HCO3)	246
Calcium (Ca) (DIS)	74
Carbonate As CO3	<1
Chloride (Cl)	219
Magnesium (Mg) (DIS)	18
Potassium (K) (DIS)	12
Sodium (Na) (DIS)	561
Sulfate (SO4)	998

Metals: ppm unless noted

Arsenic (As) (DIS)	49	49	43	46	46	46
Arsenic +3		51		48	58	63
Arsenic +5		2.2		2.2	2.4	2.6
Cadmium (Cd) (DIS)	<0.001	<0.001	<0.001	<0.001		
Iron (Fe) (DIS)	0.2	0.1	0.2	0.2		
Lead (Pb) (DIS)	<0.005	<0.005	<0.005	<0.005		
Manganese (Mn) (DIS)	2.8	2.9	2.8	2.9		
Zinc (Zn) (DIS)	0.2	0.2	0.2	0.2		

Physical/Fld-Lab: ppm unless noted

Iron (Fe) (Fld)		0.2	0.2	0.2	0.2	
Iron (Fe+2) (Fld)		0.2	0.2	0.2	0.2	
Oxygen (O) (DIS) (Fld)	0.6	1	1.3	1	0.6	0.6
pH				7		
Depth To Water Level (ft)		33.4	33.2	32.8	32.5	
Eh (millivolts)	211	214	206	199	194	190
pH (Fld)	7.08	7.02	7	7	6.9	6.9
SC (umhos/cm at 25 C) (Fld)	2900	3110	3190	2620	3160	3210
SC (umhos/cm at 25 C)				3060		
Water Temperature (C) (Fld)	13.5	14.2	13.3	14.5	14.9	14.9

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-1	STW-1	STW-1	STW-1	STW-1	STW-1
Water	SAMPLE DATE	7/13/2000	7/24/2000	8/3/2000	8/16/2000	8/31/2000	9/13/2000
	SAMPLE TIME	13:45	15:15	12:30	13:20	13:40	14:55
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L001116009	L001190009	L001239009	L001333009	L001441008	L001513010
	SAMPLE NUMBER	EHST-0007-108	EHST-0007-208	EHST-0008-108	EHST-0008-208	EHST-0008-307	EHST-0009-109
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						

Common Ions: ppm unless noted

Bicarbonate (HCO3)				264		
Calcium (Ca) (DIS)				66		
Carbonate As CO3				<1		
Chloride (Cl)				185		
Magnesium (Mg) (DIS)				15		
Potassium (K) (DIS)				12		
Sodium (Na) (DIS)				506		
Sulfate (SO4)				1072 J		

Metals: ppm unless noted

Arsenic (As) (DIS)	49	48	47	49	47	51
Arsenic +3	52 J	47	64	48	54	49
Arsenic +5	2.4	2.6	2.8 J	2.6	2.6	2.7
Cadmium (Cd) (DIS)			<0.001			
Iron (Fe) (DIS)			0.3			
Lead (Pb) (DIS)			<0.005			
Manganese (Mn) (DIS)			2.5			
Zinc (Zn) (DIS)			0.2			

Physical/Fld-Lab: ppm unless noted

Iron (Fe) (Fld)	0.3	0.3		0.2	0.2	
Iron (Fe+2) (Fld)	0.2	0.2	0.2	0.1	0.2	
Oxygen (O) (DIS) (Fld)	1	1.2	0.8	0.7	0.7	1.01
pH			7.2			
Depth To Water Level (ft)	32.4	32.4	32.5	32.6	32.9	33.2
Eh (millivolts)	181	186	204	200	212	245
pH (Fld)	7	7	7.2	7.8	7.5	7.5
SC (umhos/cm at 25 C) (Fld)	3130	3170	3020	2980	2720	3050
SC (umhos/cm at 25 C)			3000			
Water Temperature (C) (Fld)	15.1	15	14.9	14	13.7	14.2

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-1	STW-1	STW-1	STW-1	STW-1	STW-1
Water	SAMPLE DATE	10/3/2000	11/3/2000	12/20/2000	2/7/2001	5/14/2001	9/26/2001
	SAMPLE TIME	14:00	13:15	10:20	12:20	15:00	12:40
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L001649008	L001861005	L002044002	L010183009	L010699006	L011367010
	SAMPLE NUMBER	EHST-0010-107	EHST-0011-104	EHST-0012-101	EHST-0102-108	EHC-0105-196	EHST-0109-109
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						
Common Ions: ppm unless noted							
	Bicarbonate (HCO3)			266		227	239
	Calcium (Ca) (DIS)			62		87	
	Carbonate As CO3			<1			<1
	Chloride (Cl)			173		277	
	Magnesium (Mg) (DIS)			14		19	
	Potassium (K) (DIS)			12		14	
	Sodium (Na) (DIS)			581		593	
	Sulfate (SO4)			965		1250	869
	Total Alkalinity As CaCO3			218		186	196
Metals: ppm unless noted							
	Aluminum (Al) (DIS)					<0.05	
	Arsenic (As) (DIS)	55	52	51	48	47	43
	Arsenic +3	52	53	56	62	59	45
	Arsenic +5	2.7	3	3.1	2.8	<0.005	<0.005
	Cadmium (Cd) (DIS)			0.002		0.002	<0.001
	Copper (Cu) (DIS)			<0.004		0.01	
	Iron (Fe) (DIS)			0.2	0.3	0.3	0.2
	Lead (Pb) (DIS)			0.005		<0.005	0.01
	Manganese (Mn) (DIS)			2.3		3.1	2.4
	Zinc (Zn) (DIS)			0.2		0.2	0.2
Other: ppm unless noted							
	Silicon+Silica (Si+SiO2)					25	
Physical/Fid-Lab: ppm unless noted							
	Iron (Fe) (Fid)	0.2					0.2
	Iron (Fe+2) (Fid)	0.2	0.2	0.2			0.3
	Oxygen (O) (DIS) (Fid)	0.6	0.7	0.9	1.09	1.08	0.1
	pH			7.5		7.4	
	Depth To Water Level (ft)	33.7	33.2	34.09	34.8	34.7	30.8
	Eh (millivolts)		216	226	215	222	190
	pH (Fid)	7	7.05	7.4	7.5	8	6.6
	SC (umhos/cm at 25 C) (Fid)	2200	2590	2980	2740	2240	2920
	SC (umhos/cm at 25 C)			2790		3200	
	Total Suspended Solids					25	
	TDS (Measured at 180 C)			1988		2332	
	Water Temperature (C) (Fid)	12.7	12.2	9.5	11.4	15.2	12.7

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-1	STW-1	STW-1	STW-1	STW-1	STW-1
Water	SAMPLE DATE	11/2/2001	11/20/2001	12/7/2001	12/19/2001	1/10/2002	1/23/2002
	SAMPLE TIME	13:23	00:00	13:30	14:00	09:50	10:25
	LAB	HYDRO	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	FIELD ONLY	L011587011	L011626012	L011661012	L020025001	L020042001
	SAMPLE NUMBER	EHST-0111-101	EHST-0111-210	EHST-0112-211	EHST-0112-411	EHST-0201-100	EHST-0201-300
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						
Common Ions: ppm unless noted							
	Bicarbonate (HCO3)		261	271	203	312	264
	Carbonate As CO3		<1	<1	<1	<1	<1
	Sulfate (SO4)		784	697	897	921	1044
	Total Alkalinity As CaCO3		214	222	166	256	216
Metals: ppm unless noted							
	Arsenic (As) (DIS)		37	46	46	44	45
	Arsenic +3		43	46	53	39	36
	Arsenic +5		3	1	<0.02	6	8.7
	Cadmium (Cd) (DIS)			<0.001	0.007	0.006	0.001
	Iron (Fe) (DIS)			0.2	0.2	0.2	0.2
	Lead (Pb) (DIS)			<0.005	<0.005	<0.005	<0.005
	Manganese (Mn) (DIS)			2.4	2.4	2.4	2.4
	Zinc (Zn) (DIS)			0.2	0.2	0.2	0.1
Physical/Fld-Lab: ppm unless noted							
	Iron (Fe) (Fld)	0.2	0.2				
	Iron (Fe+2) (Fld)	0.2	0.2				
	Oxygen (O) (DIS) (Fld)	0.03	0.06	0.2	0.1	0.1	0.1
	Depth To Water Level (ft)	31.8	32.3	32.8	33.1	33.7	34.01
	pH (Fld)	7.04	7.4	7.2	7.1	7.1	6.7
	SC (umhos/cm at 25 C) (Fld)	2900	2820	2980	2900	29.1	2970
	Water Temperature (C) (Fld)	12.4	12.8	12.3	12.4	12.3	12.5

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-1	STW-1	STW-1	STW-1	STW-1	STW-1
Water	SAMPLE DATE	2/5/2002	2/19/2002	2/27/2002	4/19/2002	5/10/2002	6/6/2002
	SAMPLE TIME	15:00	15:20	10:50	15:50	00:00	00:00
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	ASARCO	ASARCO
	LAB NUMBER	L020075013	L020110013	L020142001	L020278011	205110	206109
	SAMPLE NUMBER	EHST-0202-412	EHST-0202-912	EHST-0202-200	EHST-0204-110	EHST-0205-110	EHST-0206-109
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RJ	RJ	RJ	RJ	RJ	RJ
	DESCRIPTION						
	REMARKS						

Common Ions: ppm unless noted

Bicarbonate (HCO3)	276	310	315	248
Carbonate As CO3	<1	<1	<1	<1
Sulfate (SO4)	981	1108	944	1026
Total Alkalinity As CaCO3	226	254	258	203

Metals: ppm unless noted

Arsenic (As) (DIS)	47	44	44	42
Arsenic +3	36	11		40
Arsenic +5	12	32		1
Cadmium (Cd) (DIS)	<0.001	<0.001		<0.001
Copper (Cu) (DIS)		0.02		
Iron (Fe) (DIS)	0.3	0.2	0.2	0.2
Lead (Pb) (DIS)	<0.005	<0.005		<0.005
Manganese (Mn) (DIS)	2.6	2.4		2.4
Zinc (Zn) (DIS)	0.1	0.1		0.2

Physical/Fld-Lab: ppm unless noted

Oxygen (O) (DIS) (Fld)	0.9	0.5	0.2	0.4
pH		7.6		
Depth To Water Level (ft)	34.4	34.8	35.04	35.8
pH (Fld)	7.1	7.3	6.9	7.5
SC (umhos/cm at 25 C) (Fld)	2880	3000	3010	3070
SC (umhos/cm at 25 C)		3000		
Water Temperature (C) (Fld)	12.4	12.6	12.4	13.1

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-1	STW-1	STW-1	STW-1	STW-1	STW-1
Water	SAMPLE DATE	7/17/2002	7/24/2002	8/8/2002	9/26/2002	11/13/2002	6/2/2003
	SAMPLE TIME	14:40	00:00	14:45	00:00	12:45	11:45
	LAB	ASARCO	ASARCO	TSC-SLC	ASARCO	TSC-SLC	TSC-SLC
	LAB NUMBER	207102	207305	L020638003	209611	L020943009	L030245007
	SAMPLE NUMBER	EHST-0207-102	EHST-0207-305	EHST-0208-102	EHST-0209-611	EHC-0211-212	AEH-0306-169
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						

Common Ions: ppm unless noted

Bicarbonate (HCO3)	226	287	234
Calcium (Ca) (DIS)		70	69
Carbonate As CO3	<1	<1	<2
Chloride (Cl)		183	171
Magnesium (Mg) (DIS)		15	17
Potassium (K) (DIS)		15	17
Sodium (Na) (DIS)		524	450
Sulfate (SO4)	1049	895	831
Total Alkalinity As CaCO3	185	235	192

Metals: ppm unless noted

Aluminum (Al) (DIS)		<0.05	
Arsenic (As) (DIS)	32	34	25
Arsenic +3	30	34	33
Arsenic +5	4	<0.005	<0.005
Cadmium (Cd) (DIS)		<0.001	<0.001
Copper (Cu) (DIS)		<0.004	<0.004 UJ
Iron (Fe) (DIS)	0.3	0.3	0.4
Lead (Pb) (DIS)		<0.005	<0.005
Manganese (Mn) (DIS)		2.4	2.4
Zinc (Zn) (DIS)		0.1	0.2

Other: ppm unless noted

Silicon+Silica (Si+SiO2)		25	
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Physical/Fld-Lab: ppm unless noted

Oxygen (O) (DIS) (Fld)		0.8	0.4	0.2	0.1
pH				7.3	7.2
Depth To Water Level (ft)	30.9		30.7	30.8	32.2
pH (Fld)		6.1	6.9		6.5
SC (umhos/cm at 25 C) (Fld)		6830	2830		2690
SC (umhos/cm at 25 C)					2730
Total Suspended Solids					5.2
TDS (Measured at 180 C)					1899
Salinity (G/KG) (Fld)					
Turbidity (NTU) (Fld)					4
Water Temperature (C) (Fld)		19.5	13		12

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-1	STW-1	STW-2	STW-2	STW-2
Water	SAMPLE DATE	10/30/2003	5/20/2004	5/10/2000	5/18/2000	5/30/2000
	SAMPLE TIME	09:00	11:35	15:50	11:45	13:20
	LAB	TSC-SLC	ELI	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L030605015	H04050133-008	L000720006	L000759004	L000825006
	SAMPLE NUMBER	AEH-0310-438	AEH-0405-131	EHST-0005-105	EHST-0005-113	EHST-0005-125
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RJ	RJ	RJ	RJ	RJ
	DESCRIPTION					
	REMARKS					

Common Ions: ppm unless noted

Bicarbonate (HCO3)	281	268		
Calcium (Ca) (DIS)	76	78		
Carbonate As CO3	<2	<1		
Chloride (Cl)	124	178		
Magnesium (Mg) (DIS)	18	19		
Potassium (K) (DIS)	16	13		
Sodium (Na) (DIS)	405	464		
Sulfate (SO4)	746	856		
Total Alkalinity As CaCO3	230			

Common Ions (mg/L): ppm unless noted

Bicarbonate (HCO3)	240			
Calcium (Ca) (DIS)	88			
Chloride (Cl)	120			
Magnesium (Mg) (DIS)	19			
Potassium (K) (DIS)	17			
Sodium (Na) (DIS)	352			
Sulfate (SO4)	820			
Total Alkalinity As CaCO3	190			

Metals: ppm unless noted

Arsenic (As) (DIS)	25	24	27	29
Arsenic +3	30	14		
Arsenic +5	<0.05	11		
Cadmium (Cd) (DIS)	<0.001	<0.001	<0.001	<0.001
Copper (Cu) (DIS)	0.004			
Iron (Fe) (DIS)	0.4	<0.05	<0.05	<0.02
Lead (Pb) (DIS)	<0.005	<0.005	<0.005	<0.005
Manganese (Mn) (DIS)	2.6	2.7	2.7	2.5
Zinc (Zn) (DIS)	0.2	0.2	0.2	0.2

Metals (mg/L): ppm unless noted

Arsenic (As) (DIS)	17.6			
Arsenic +3	<0.006 J			
Arsenic +5	20 J			
Cadmium (Cd) (DIS)	<0.001			
Copper (Cu) (DIS)	<0.004			
Iron (Fe) (DIS)	0.54			
Lead (Pb) (DIS)	<0.005			
Manganese (Mn) (DIS)	3.18			
Zinc (Zn) (DIS)	0.2			

Physical/Fld-Lab: ppm unless noted

Iron (Fe) (Fld)	0.1	0.03	0.02
Iron (Fe+2) (Fld)	0.2	0.01	0.03

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-1	STW-1	STW-2	STW-2	STW-2
Water	SAMPLE DATE	10/30/2003	5/20/2004	5/10/2000	5/18/2000	5/30/2000
	SAMPLE TIME	09:00	11:35	15:50	11:45	13:20
	LAB	TSC-SLC	ASARCO	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L030605015	H04050133-008	L000720006	L000759004	L000825006
	SAMPLE NUMBER	AEH-0310-438	AEH-0405-131	EHST-0005-105	EHST-0005-113	EHST-0005-125
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI
	DESCRIPTION					
	REMARKS					

Physical/Fld-Lab: ppm unless noted

Oxygen (O) (DIS) (Fld)	0.07		1.07	1.05	5.2
Oxygen (O) (DIS) (Fld) (DIS)		0.26			
pH	7.8	7.3	7.8		
Depth To Water Level (ft)	32.11	33.6	33.04	33	32.9
Eh (millivolts)			274	287	348
pH (Fld)	6.42	6.39	6.8	7	7.07
SC (umhos/cm at 25 C) (Fld)	2300	2200		2640	2700
SC (umhos/cm at 25 C)	2320	2290	2650		
Total Suspended Solids	17 J	54			
TDS (Measured at 180 C)	1614	1520			
Salinity (G/KG) (Fld)	1	1			
Turbidity (NTU) (Fld)	29	10			
Water Temperature (C) (Fld)	11.8	13.4	12.4	13.5	13.5

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-2	STW-2	STW-2	STW-2	STW-2	STW-2
Water	SAMPLE DATE	6/6/2000	6/13/2000	6/21/2000	6/29/2000	7/13/2000	7/24/2000
	SAMPLE TIME	11:20	12:10	13:20	12:20	12:20	13:35
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L000882004	L000910005	L000964007	L001003005	L001116005	L001190004
	SAMPLE NUMBER	EHST-0006-103	EHST-0006-204	EHST-0006-306	EHST-0006-404	EHST-0007-104	EHST-0007-203
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						
Common Ions: ppm unless noted							
	Bicarbonate (HCO ₃)			156			
	Calcium (Ca) (DIS)			71			
	Carbonate As CO ₃			<1			
	Chloride (Cl)			160			
	Magnesium (Mg) (DIS)			18			
	Potassium (K) (DIS)			12			
	Sodium (Na) (DIS)			465			
	Sulfate (SO ₄)			841			
Metals: ppm unless noted							
	Arsenic (As) (DIS)	28	27	26	25	25	27
	Arsenic +3	3.3 J		0.03 U	0.009 U	0.02 UJ	0.01 U
	Arsenic +5	28		22	24	26	26
	Cadmium (Cd) (DIS)	<0.001	<0.001	<0.001			
	Iron (Fe) (DIS)	<0.05	<0.02	<0.03			
	Lead (Pb) (DIS)	<0.005 J	<0.005	<0.005			
	Manganese (Mn) (DIS)	2.4	2.2	2			
	Zinc (Zn) (DIS)	0.2	0.2	0.1			
Physical/Fld-Lab: ppm unless noted							
	Iron (Fe) (Fld)	0.02	0.01	0.01	<0.01	<0.01	0.03
	Iron (Fe+2) (Fld)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Oxygen (O) (DIS) (Fld)	5.6	5.8	7.8	6.8	9.7	9.5
	pH			7.6			
	Depth To Water Level (ft)	32.7	32.6	32	31.8	31.7	31.9
	Eh (millivolts)	312	365	431	363	390	355
	pH (Fld)	6.9	6.8	7	7	7.2	7.05
	SC (umhos/cm at 25 C) (Fld)	2780	2890	2520	2650	2700	2790
	SC (umhos/cm at 25 C)			2610			
	Water Temperature (C) (Fld)	13.8	12.8	13.3	14.9	14.5	14.9

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-1	STW-2	STW-2	STW-2	STW-2	STW-2
Water	SAMPLE DATE	8/3/2000	8/16/2000	8/31/2000	9/13/2000	9/13/2000	10/3/2000
	SAMPLE TIME	11:20	12:15	13:20	13:40	13:55	12:00
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L001239006	L001333006	L001441007	L001513006	L001513007	L001649004
	SAMPLE NUMBER	EHST-0008-105	EHST-0008-205	EHST-0008-306	EHST-0009-105	EHST-0009-106	EHST-0010-103
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS					Field Duplicate	

Common Ions: ppm unless noted

Bicarbonate (HCO3)	154
Calcium (Ca) (DIS)	72
Carbonate As CO3	<1
Chloride (Cl)	194
Magnesium (Mg) (DIS)	17
Potassium (K) (DIS)	12
Sodium (Na) (DIS)	448
Sulfate (SO4)	1008 J

Metals: ppm unless noted

Arsenic (As) (DIS)	28	28	27	27	23	23
Arsenic +3	0.02 U	<0.02	<0.02	0.5	0.6	2
Arsenic +5	34 J	27	25	25	22	26
Cadmium (Cd) (DIS)	<0.001					
Iron (Fe) (DIS)	<0.02					
Lead (Pb) (DIS)	<0.005					
Manganese (Mn) (DIS)	1.4					
Zinc (Zn) (DIS)	0.1					

Physical/Fid-Lab: ppm unless noted

Iron (Fe) (Fid)		0.01	0.01			0.01
Iron (Fe+2) (Fid)	<0.01	<0.01	<0.01			<0.01
Oxygen (O) (DIS) (Fid)	8.6	2.9	1.08	1.06	1.04	0.6
pH	7.7					
Depth To Water Level (R)	31.8	31.8	32.1	32.5		32.9
Eh (millivolts)	407	438	332	424	418	
pH (Fid)	7	7.4	7.4	7.8	7.8	6.9
SC (umhos/cm at 25 C) (Fid)	2820	2400	2910	3010	3000	2560
SC (umhos/cm at 25 C)	2760					
Water Temperature (C) (Fid)	14.2	14.2	13.7	14.1	14.1	12.6

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-2	STW-2	STW-2	STW-2	STW-2	STW-2
Water	SAMPLE DATE	12/20/2000	5/14/2001	5/14/2001	9/26/2001	10/19/2001	11/2/2001
	SAMPLE TIME	13:20	15:15	15:30	11:15	14:10	11:37
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	HYDRO	HYDRO
	LAB NUMBER	L002044007	L010699003	L010699015	L011367006	FIELD ONLY	FIELD ONLY
	SAMPLE NUMBER	EHST-0012-106	EHC-0105-197	EHC-0105-232	EHST-0109-105	EHST-0110-101	EHST-0111-102
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS			Field Duplicate			

Common Ions: ppm unless noted

Bicarbonate (HCO3)	310	232	233	231
Calcium (Ca) (DIS)	87	99	99	
Carbonate As CO3	<1			<1
Chloride (Cl)	161	210	239	
Magnesium (Mg) (DIS)	20	23	22	
Potassium (K) (DIS)	13	15	15	
Sodium (Na) (DIS)	542	472	489	
Sulfate (SO4)	1022	1038	1005	915
Total Alkalinity As CaCO3	254	190	191	189

Metals: ppm unless noted

Aluminum (Al) (DIS)		<0.05	<0.05	
Arsenic (As) (DIS)	26	24	24	27
Arsenic +3	6.7	16	19	28
Arsenic +5	18	8	4	<0.005
Cadmium (Cd) (DIS)	0.002	0.003	0.003	<0.001
Copper (Cu) (DIS)	0.01	0.02	0.02	
Iron (Fe) (DIS)	<0.02	<0.05	<0.05	0.02
Lead (Pb) (DIS)	<0.005	<0.005	<0.005	<0.005
Manganese (Mn) (DIS)	2.4	3.3	3.3	3.2
Zinc (Zn) (DIS)	0.2	0.2	0.2	0.2

Other: ppm unless noted

Silicon+Silica (Si+SiO2)		28	28	
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Physical/Fld-Lab: ppm unless noted

Iron (Fe) (Fld)				<0.01	<0.01	<0.01
Iron (Fe+2) (Fld)	<0.01			<0.01	<0.01	<0.01
Oxygen (O) (DIS)	0.9	1.05	1.05	0.1	5.6	6.3
pH	8.2	7.5	7.4			
Depth To Water Level (ft)	33.4	34		30	30.8	31
Eh (millivolts)	399	415	412	185	335	
pH (Fld)	7.2	7.7	7.7	6.6	7.05	6.9
SC (umhos/cm at 25 C) (Fld)	2970	1985	1978	2800	2680	2650
SC (umhos/cm at 25 C)	2860	2770	2770			
Total Suspended Solids		4.8	4.4			
TDS (Measured at 180 C)	2054	1990	2017			
Water Temperature (C) (Fld)	12	14.5	14.5	12.5	12.2	12.3

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-2	STW-2	STW-2	STW-2	STW-2	STW-2
Water	SAMPLE DATE	11/20/2001	11/30/2001	12/4/2001	12/7/2001	12/12/2001	12/14/2001
	SAMPLE TIME	00:00	13:40	15:00	12:35	12:00	11:30
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	HYDRO	TSC-SLC
	LAB NUMBER	L011587010	L011606001	L011614001	L011626007	FIELD ONLY	L011652005
	SAMPLE NUMBER	EHST-0111-209	EHST-0111-300	EHST-0112-100	EHST-0112-206	EHST-0112-250	EHST-0112-304
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						
Common Ions: ppm unless noted							
	Bicarbonate (HCO3)	155	170	170	192		176
	Carbonate As CO3	<1	<1	<1	<1		<1
	Sulfate (SO4)	697	827	847	719		839
	Total Alkalinity As CaCO3	127	139	139	157		144
Metals: ppm unless noted							
	Arsenic (As) (DIS)	26	25	26	23		25
	Arsenic +3	10			9.1		
	Arsenic +5	18			15		
	Cadmium (Cd) (DIS)				<0.001		
	Iron (Fe) (DIS)		0.02	<0.02	<0.02		<0.02
	Lead (Pb) (DIS)				<0.005		
	Manganese (Mn) (DIS)				2.4		
	Zinc (Zn) (DIS)				0.2		
Physical/Fld-Lab: ppm unless noted							
	Iron (Fe) (Fid)	<0.01	0.2				
	Iron (Fe+2) (Fid)	<0.01		<0.01	<0.01	<0.01	<0.01
	Oxygen (O) (DIS) (Fid)	6.2	3.3	3.5	5.5	6.3	5.01
	Depth To Water Level (R)	31.4		31.8	32	32.1	32.1
	pH (Fid)	6.8	7.01	6.9	7.01	6.9	7.03
	SC (umhos/cm at 25 C) (Fid)	2620	2640	2580	2690	2660	2710
	Water Temperature (C) (Fid)	12.5	12.2	12.3	12.1	12.3	12.2

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-2	STW-2	STW-2	STW-2	STW-2	STW-2
Water	SAMPLE DATE	12/19/2001	12/27/2001	1/10/2002	1/16/2002	1/23/2002	2/5/2002
	SAMPLE TIME	12:30	13:30	11:20	12:30	12:05	14:20
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L011661006	L011677005	L020025006	L020027007	L020042009	L020075009
	SAMPLE NUMBER	EHST-0112-405	EHST-0112-504	EHST-0201-105	EHST-0201-206	EHST-0201-308	EHST-0202-408
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RJ	RJ	RJ	RJ	RJ	RJ
	DESCRIPTION						
	REMARKS						

Common Ions: ppm unless noted

Bicarbonate (HCO3)	171	168	200	188	173	198
Carbonate As CO3	<1	7	<1	<1	<1	<1
Sulfate (SO4)	944	855	860	863	930	921
Total Alkalinity As CaCO3	140	150	164	154	142	162

Metals: ppm unless noted

Arsenic (As) (DIS)	26	25	23	25	23	24
Arsenic +3	10		9		6.7	6.9
Arsenic +5	16		14		18	17
Cadmium (Cd) (DIS)	<0.001		0.003		0.001	<0.001
Iron (Fe) (DIS)	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Lead (Pb) (DIS)	<0.005		<0.005		<0.005	<0.005
Manganese (Mn) (DIS)	2		2		1.8	2.2
Zinc (Zn) (DIS)	0.2		0.1		0.1	0.1

Physical/Fld-Lab: ppm unless noted

Oxygen (O) (DIS) (Fld)	7.2	7.2	5.03	6.3	6.4	6.4
Depth To Water Level (ft)	32.2	34.5	32.9	33.04	33.3	33.6
pH (Fld)	6.9	6.4	7	6.9	6.7	7.05
SC (umhos/cm at 25 C) (Fld)	2610	2600	2340	2470	2570	2560
Water Temperature (C) (Fld)	12.4	12.3	12.3	12.3	12.3	12.4

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-2	STW-2	STW-2	STW-2	STW-2	STW-2
Water	SAMPLE DATE	2/12/2002	2/13/2002	2/14/2002	2/15/2002	2/19/2002	2/22/2002
	SAMPLE TIME	10:10	14:40	00:00	00:00	13:50	10:50
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L020056003	L020096006	L020101002	L020101007	L020110005	L020118005
	SAMPLE NUMBER	EHST-0202-502	EHST-0202-600	EHST-0202-701	EHST-0202-801	EHST-0202-904	EHST-0202-104
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						
Common Ions: ppm unless noted							
	Bicarbonate (HCO3)	179	181	181	171	151	166
	Carbonate As CO3	<1	<1	<1	<1	<1	<1
	Sulfate (SO4)	845	897	818	851	897	965
	Total Alkalinity As CaCO3	147	148	148	140	124	136
Metals: ppm unless noted							
	Arsenic (As) (DIS)	24	23	23	25	25	23
	Arsenic +3					7.8	
	Arsenic +5					16	
	Cadmium (Cd) (DIS)					<0.001	
	Copper (Cu) (DIS)					0.02	
	Iron (Fe +2)			<0.01	<0.01		
	Iron (Fe) (DIS)	<0.02	<0.02	<0.02	<0.02	0.05	<0.02
	Lead (Pb) (DIS)					<0.005	
	Manganese (Mn) (DIS)					1.5	
	Zinc (Zn) (DIS)					0.1	
Physical/Fld-Lab: ppm unless noted							
	Iron (Fe) (Fld)	<0.01	<0.01				
	Oxygen (O) (DIS) (Fld)	6.9	5.7	7.7	8.6	7.6	8
	pH					7.7	
	Depth To Water Level (ft)	34	33.9	34.1	34.05	34.05	34.1
	pH (Fld)	7.1	7.2	7.2	7.2	7.2	7.4
	SC (umhos/cm at 25 C) (Fld)	2620	2520	2510	2600	2670	2640
	SC (umhos/cm at 25 C)					2650	
	Water Temperature (C) (Fld)	12.1	12.5	12.1	12.3	12.4	12.6

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-2	STW-2	STW-2	STW-2	STW-2	STW-2
Water	SAMPLE DATE	2/27/2002	4/19/2002	5/10/2002	6/6/2002	7/17/2002	7/24/2002
	SAMPLE TIME	13:15	13:45	00:00	13:45	15:30	13:00
	LAB	TSC-SLC	TSC-SLC	ASARCO	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L020142010	L020278004	205106	L020426003	L020591005	L020594003
	SAMPLE NUMBER	EHST-0202-209	EHST-0204-103	EHST-0205-106	EHST-0206-102	EHST-0207-105	EHST-0207-302
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						

Common Ions: ppm unless noted

Bicarbonate (HCO ₃)	166	176		156	154	151
Calcium (Ca) (DIS)				98		
Carbonate As CO ₃	<1	<1		<1	<1	<1
Chloride (Cl)				214		
Magnesium (Mg) (DIS)				23		
Potassium (K) (DIS)				14		
Sodium (Na) (DIS)				517		
Sulfate (SO ₄)	1022	925		1158	1100	1041
Total Alkalinity As CaCO ₃	136	144		128	126	124

Metals: ppm unless noted

Aluminum (Al) (DIS)				<0.05		
Arsenic (As) (DIS)	23	23		21	18	20
Arsenic +3		7.6		5.7	13	16
Arsenic +5		14		15	6	4
Cadmium (Cd) (DIS)		0.001		<0.001		<0.001
Copper (Cu) (DIS)				0.01		
Iron (Fe) (DIS)	<0.02	<0.02		<0.02	<0.02	<0.02
Lead (Pb) (DIS)		<0.005		<0.005		<0.005
Manganese (Mn) (DIS)		1.5		1.3		1.4
Zinc (Zn) (DIS)		0.1		0.09		0.1

Other: ppm unless noted

Silicon+Silica (Si+SiO ₂)				23		
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Physical/Fid-Lab: ppm unless noted

Oxygen (O) (DIS) (Fid)	8.2	7.6		7.7	9.2	10.6
pH				7.3		
Depth To Water Level (ft)	35.2	35	35	34.2	31.4	
pH (Fid)	7.06	7.3		7.2	7.4	7.1
SC (umhos/cm at 25 C) (Fid)	2750	2880		2650	2390	2120
SC (umhos/cm at 25 C)				2760		
Total Suspended Solids				3.7		
TDS (Measured at 180 C)				1992		
Water Temperature (C) (Fid)	12.1	12.8		13.5	13.2	13.2

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-2	STW-2	STW-2	STW-2	STW-2	STW-2
Water	SAMPLE DATE	7/31/2002	8/8/2002	8/14/2002	8/22/2002	8/28/2002	9/4/2002
	SAMPLE TIME	12:30	15:45	14:15	11:45	13:55	15:05
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L020606004	L020638007	L020650004	L020686005	L020705003	L020731003
	SAMPLE NUMBER	EHST-0207-503	EHST-0208-106	EHST-0208-303	EHST-0208-502	EHST-0208-602	EHST-0209-102
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RJ	RJ	RJ	RJ	RJ	RJ
	DESCRIPTION						
	REMARKS						
Common Ions: ppm unless noted							
	Bicarbonate (HCO3)	149	146	142	171	170	142
	Carbonate As CO3	<1	<1	<1	<1	<1	<1
	Sulfate (SO4)	1102	1160	1122	1066	1038	1133
	Total Alkalinity As CaCO3	122	120	116	140	139	116
Metals: ppm unless noted							
	Arsenic (As) (DIS)	18	17	17	24	25	17
	Arsenic +3	15	13	16	19	8.6	14
	Arsenic +5	4	4	1	6	16	4
	Iron (Fe) (DIS)	<0.02	<0.02	<0.02	0.04	0.04	<0.02
Physical/Fld-Lab: ppm unless noted							
	Oxygen (O) (DIS) (Fld)	10.3	10	6.2	6.8	6.7	6.8
	Depth To Water Level (ft)	30.3	29.6	29.7	29.8	29.7	29.8
	pH (Fld)	7.2	7.1	7.1	7.04	7.4	7.2
	SC (umhos/cm at 25 C) (Fld)	2800	3090	2360	3450	2520	2070
	TDS (Measured at 180 C)						2.070213E+07
	Water Temperature (C) (Fld)	13.1	12.4	13.4	12.6	12.6	12.6

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-2	STW-2	STW-2	STW-2	STW-2	STW-2
Water	SAMPLE DATE	9/19/2002	9/26/2002	10/4/2002	10/17/2002	10/23/2002	10/31/2002
	SAMPLE TIME	12:10	16:45	14:15	10:50	13:15	14:30
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L020785004	L020829008	L020845002	L020869002	L020888002	L020915002
	SAMPLE NUMBER	EHST-0209-403	EHST-0209-607	EHST-0210-101	EHST-0210-301	EHST-0210-401	EHST-0210-501
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						
Common Ions: ppm unless noted							
	Bicarbonate (HCO3)	150	144	154	161	159	142
	Carbonate As CO3	<1	<1	<1	<1	<1	<1
	Sulfate (SO4)	1087	975	948	1010	1069	936
	Total Alkalinity As CaCO3	123	118	126	132	130	116
Metals: ppm unless noted							
	Arsenic (As) (DIS)	18	19	17	17	19	17
	Arsenic +3	14	17	13	16	18	16
	Arsenic +5	4	1	4	<0.005	<0.005	0.7
	Iron (Fe) (DIS)	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Physical/Fld-Lab: ppm unless noted							
	Oxygen (O) (DIS) (Fld)	7.08	6.4	6.2	7.3	7.3	6.7
	Depth To Water Level (ft)	31.2	30.1	30.3	30.6	30.8	31.04
	pH (Fld)	7.2	7.2	7.2	7.09	7.2	7.4
	SC (umhos/cm at 25 C) (Fld)	2710	2540	1638	2690	2710	2780
	Water Temperature (C) (Fld)	12.5	12.3	12.4	11.9	12	11.3

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-2	STW-2	STW-2	STW-2	STW-3
Water	SAMPLE DATE	11/13/2002	6/2/2003	10/30/2003	5/13/2004	5/10/2000
	SAMPLE TIME	12:10	00:00	00:00	13:21	12:50
	LAB	TSC-SLC	ASARCO	TSC-SLC	ASARCO	TSC-SLC
	LAB NUMBER	L020943006	0306-228	AEH-0310-461	AEH-0405-246	L000720002
	SAMPLE NUMBER	EHC-0211-213	AEH-0306-228	AEH-0310-461	AEH-0405-246	EHST-0005-101
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI
	DESCRIPTION			SWL Only Req	SWL Only Req	
	REMARKS					
Common Ions: ppm unless noted						
	Bicarbonate (HCO3)	167				259
	Calcium (Ca) (DIS)	118				73
	Carbonate As CO3	<1				<1
	Chloride (Cl)	188				188
	Magnesium (Mg) (DIS)	27				18
	Potassium (K) (DIS)	16				13
	Sodium (Na) (DIS)	485				452
	Sulfate (SO4)	1122				842
	Total Alkalinity As CaCO3	137				
Metals: ppm unless noted						
	Aluminum (Al) (DIS)	<0.05				
	Arsenic (As) (DIS)	17				22
	Arsenic +3	9.6				12
	Arsenic +5	7.4				13
	Cadmium (Cd) (DIS)	<0.001				<0.001
	Copper (Cu) (DIS)	<0.004				
	Iron (Fe) (DIS)	<0.02				<0.05
	Lead (Pb) (DIS)	<0.005				<0.005
	Manganese (Mn) (DIS)	1.2				2.9
	Zinc (Zn) (DIS)	0.08				0.1
Other: ppm unless noted						
	Silicon+Silica (Si+SiO2)	23				
Physical/Fld-Lab: ppm unless noted						
	Iron (Fe) (Fld)					0.1
	Iron (Fe+2) (Fld)					<0.1
	Oxygen (O) (DIS) (Fld)	5.2				1.4
	pH	7.7				8
	Depth To Water Level (ft)	31.5	33.4	31.24	32.82	33.5
	Eh (millivolts)					319
	pH (Fld)	7.2				6.8
	SC (umhos/cm at 25 C) (Fld)	2750				2680
	SC (umhos/cm at 25 C)	2810				2550
	Total Suspended Solids	2				
	TDS (Measured at 180 C)	2049				
	Water Temperature (C) (Fld)	11.8				11.9

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-3	STW-3	STW-3	STW-3	STW-3	STW-3
Water	SAMPLE DATE	5/18/2000	5/30/2000	6/6/2000	6/13/2000	6/21/2000	6/29/2000
	SAMPLE TIME	12:00	12:50	12:35	11:40	12:30	11:45
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L000759005	L000825005	L000882007	L000910004	L000964006	L001003004
	SAMPLE NUMBER	EHST-0005-114	EHST-0005-124	EHST-0006-106	EHST-0006-203	EHST-0006-305	EHST-0006-403
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						

Common Ions: ppm unless noted

Bicarbonate (HCO3)	150
Calcium (Ca) (DIS)	70
Carbonate As CO3	<1
Chloride (Cl)	183
Magnesium (Mg) (DIS)	17
Potassium (K) (DIS)	13
Sodium (Na) (DIS)	479
Sulfate (SO4)	897

Metals: ppm unless noted

Arsenic (As) (DIS)	25	22	21	20	22	21
Arsenic +3			3.7 J		0.5 U	0.1
Arsenic +5			21		19	21
Cadmium (Cd) (DIS)	<0.001	<0.001	<0.001	<0.001	<0.001	
Iron (Fe) (DIS)	0.05	<0.02	<0.05	<0.02	<0.03	
Lead (Pb) (DIS)	<0.005	<0.005	<0.005 J	<0.005	<0.005	
Manganese (Mn) (DIS)	3.3	2.6	2.5	2.2	2.2	
Zinc (Zn) (DIS)	0.2	0.2	0.1	0.1	0.1	

Physical/Fld-Lab: ppm unless noted

Iron (Fe) (Fld)	0.09	0.01	<0.01	<0.01	<0.01	<0.01
Iron (Fe+2) (Fld)	0.07	0.0	<0.01	<0.01	<0.01	<0.01
Oxygen (O) (DIS) (Fld)	1.02	4.9	4.6	5.2	6.5	5.7
pH					7.5	
Depth To Water Level (ft)	33.4	33.3	33.1	33.03	32.4	32.2
Eh (millivolts)	274	332	327	347	368	363
pH (Fld)	7	7.1	6.9	6.9	7.03	7
SC (umhos/cm at 25 C) (Fld)	2580	2620	2620	2910	2370	2570
SC (umhos/cm at 25 C)					2580	
Water Temperature (C) (Fld)	13.7	12.6	14	12.8	13.9	14.5

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-3	STW-3	STW-3	STW-3	STW-3	STW-3
Water	SAMPLE DATE	7/13/2000	7/24/2000	7/24/2000	8/3/2000	8/16/2000	8/31/2000
	SAMPLE TIME	11:40	14:15	14:30	10:45	11:45	12:35
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L001116004	L001190005	L001190006	L001239005	L001333005	L001441006
	SAMPLE NUMBER	EHST-0007-103	EHST-0007-204	EHST-0007-205	EHST-0008-104	EHST-0008-204	EHST-0008-305
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS			Field Duplicate			
Common Ions: ppm unless noted							
	Bicarbonate (HCO3)				162		
	Calcium (Ca) (DIS)				76		
	Carbonate As CO3				<1		
	Chloride (Cl)				191		
	Magnesium (Mg) (DIS)				17		
	Potassium (K) (DIS)				12		
	Sodium (Na) (DIS)				451		
	Sulfate (SO4)				1024 J		
Metals: ppm unless noted							
	Arsenic (As) (DIS)	22	24	23	25	23	20
	Arsenic +3	0.03 UJ	0.02 U	0.03 U	0.02 U	<0.02	0.1 U
	Arsenic +5	17	23	23	26 J	23	20
	Cadmium (Cd) (DIS)				<0.001		
	Iron (Fe) (DIS)				0.04 U		
	Lead (Pb) (DIS)				0.005		
	Manganese (Mn) (DIS)				1.4		
	Zinc (Zn) (DIS)				0.1		
Physical/Fld-Lab: ppm unless noted							
	Iron (Fe) (Fld)	0.01	0.02			0.01	0.01
	Iron (Fe+2) (Fld)	<0.01	<0.01		<0.01	<0.01	<0.01
	Oxygen (O) (DIS) (Fld)	7.8	7.9	7.9	7.7	2.1	1.01
	pH				7.9		
	Depth To Water Level (ft)	32.1	32.3		32.3	32.2	32.5
	Eh (millivolts)	364	390	388	372	396	327
	pH (Fld)	7.03	7.3	7.2	7.07	7.5	7.3
	SC (umhos/cm at 25 C) (Fld)	2650	2820	2760	2900	2350	2950
	SC (umhos/cm at 25 C)				2770		
	Water Temperature (C) (Fld)	14.6	15	15	14	14.2	13.9

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-3	STW-3	STW-3	STW-3	STW-3	STW-3
Water	SAMPLE DATE	9/13/2000	10/3/2000	12/20/2000	5/14/2001	9/26/2001	10/19/2001
	SAMPLE TIME	13:05	12:40	14:10	15:45	10:55	13:30
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	HYDRO
	LAB NUMBER	L001513005	L001649005	L002044009	L010699013	L011367005	FIELD ONLY
	SAMPLE NUMBER	EHST-0009-104	EHST-0010-104	EHST-0012-108	EHST-0105-198	EHST-0109-104	EHST-0110-102
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						

Common Ions: ppm unless noted

Bicarbonate (HCO3)	272	232	217
Calcium (Ca) (DIS)	95	97	
Carbonate As CO3	<1		<1
Chloride (Cl)	174	242	
Magnesium (Mg) (DIS)	22	24	
Potassium (K) (DIS)	14	15	
Sodium (Na) (DIS)	557	469	
Sulfate (SO4)	1015	1123	841
Total Alkalinity As CaCO3	223	190	178

Metals: ppm unless noted

Aluminum (Al) (DIS)			<0.05
Arsenic (As) (DIS)	22	24	19
Arsenic +3	1.8	3.8	5.1
Arsenic +5	18	19	15
Cadmium (Cd) (DIS)		0.001	0.002
Copper (Cu) (DIS)		0.009	0.01
Iron (Fe) (DIS)		0.03	<0.05
Lead (Pb) (DIS)		0.007	<0.005
Manganese (Mn) (DIS)		3.7	4.2
Zinc (Zn) (DIS)		0.2	0.2

Other: ppm unless noted

Silicon+Silica (Si+SiO2)	28
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Physical/Fld-Lab: ppm unless noted

Iron (Fe) (Fld)		0.02		<0.01	<0.01
Iron (Fe+2) (Fld)		0.01	0.08	<0.01	<0.01
Oxygen (O) (DIS) (Fld)	1.05	0.5	1.4	0.7	6.3
pH			7.6	7.6	
Depth To Water Level (ft)	32.9	33.3	33.8	34.4	30.4
Eh (millivolts)	426		354	374	188
pH (Fld)	7.2	6.6	7.3	7.7	6.7
SC (umhos/cm at 25 C) (Fld)	3030	2550	3190	2040	2610
SC (umhos/cm at 25 C)			2880	2720	
Total Suspended Solids				24	
TDS (Measured at 180 C)			2073	1999	
Water Temperature (C) (Fld)	14.3	12.7	12.8	14.6	12.6

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-3	STW-3	STW-3	STW-3	STW-3	STW-3
Water	SAMPLE DATE	11/2/2001	11/20/2001	11/30/2001	12/4/2001	12/7/2001	12/12/2001
	SAMPLE TIME	11:20	00:00	13:10	14:00	13:00	12:40
	LAB	HYDRO	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	HYDRO
	LAB NUMBER	FIELD ONLY	L011587009	L011606002	L011614002	L011626009	FIELD ONLY
	SAMPLE NUMBER	EHST-0111-103	EHST-0111-208	EHST-0111-301	EHST-0112-101	EHST-0112-208	EHST-0112-251
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						
Common Ions: ppm unless noted							
	Bicarbonate (HCO3)		182	214	220	207	
	Carbonate As CO3		<1	<1	<1	<1	
	Sulfate (SO4)		593	744	841	661	
	Total Alkalinity As CaCO3		149	175	180	170	
Metals: ppm unless noted							
	Arsenic (As) (DIS)		21	21	22	21	
	Arsenic +3		7.6			8.7	
	Arsenic +5		14			13	
	Cadmium (Cd) (DIS)					<0.001	
	Iron (Fe) (DIS)			0.04	<0.02	<0.02	
	Lead (Pb) (DIS)					<0.005	
	Manganese (Mn) (DIS)					2.2	
	Zinc (Zn) (DIS)					0.2	
Physical/Fld-Lab: ppm unless noted							
	Iron (Fe) (Fld)	0.01	<0.01	0.7			
	Iron (Fe+2) (Fld)	<0.01	<0.01		<0.01	<0.01	<0.01
	Oxygen (O) (DIS) (Fld)	5.4	6.2	2.2	1.2	5.2	5.8
	Depth To Water Level (ft)	31.4	31.9		32.2	32.5	32.5
	pH (Fld)	6.9	6.8	7	6.9	7.06	6.9
	SC (umhos/cm at 25 C) (Fld)	2590	2580	2620	2570	2630	2530
	Water Temperature (C) (Fld)	12.4	12.6	12.1	12.3	12.3	12.3

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-3	STW-3	STW-3	STW-3	STW-3	STW-3
Water	SAMPLE DATE	12/14/2001	12/19/2001	12/27/2001	1/10/2002	1/16/2002	1/23/2002
	SAMPLE TIME	11:50	13:15	14:00	11:45	12:40	11:45
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L011652007	L011661009	L011677007	L020025008	L020027008	L020042007
	SAMPLE NUMBER	EHST-0112-306	EHST-0112-408	EHST-0112-506	EHST-0201-107	EHST-0201-207	EHST-0201-306
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						
Common Ions: ppm unless noted							
	Bicarbonate (HCO3)	207	210	196	237	207	205
	Carbonate As CO3	<1	<1	<1	<1	<1	<1
	Sulfate (SO4)	768	881	834	879	803	905
	Total Alkalinity As CaCO3	170	172	161	194	170	168
Metals: ppm unless noted							
	Arsenic (As) (DIS)	22	22	20	21	22	21
	Arsenic +3		12		8.2		6.7
	Arsenic +5		10		13		16
	Cadmium (Cd) (DIS)		<0.001		0.003		0.001
	Iron (Fe) (DIS)	0.03	<0.02	<0.02	<0.02	<0.02	<0.02
	Lead (Pb) (DIS)		<0.005		<0.005		<0.005
	Manganese (Mn) (DIS)		1.9		1.8		1.7
	Zinc (Zn) (DIS)		0.1		0.2		0.1
Physical/Fld-Lab: ppm unless noted							
	Iron (Fe+2) (Fld)	<0.01					
	Oxygen (O) (DIS) (Fld)	4.5	6.01	6.7	4.02	6	5.8
	Depth To Water Level (ft)	32.6	32.8	35.08	33.3	33.4	33.7
	pH (Fld)	7.09	7	6.5	7.1	6.9	6.7
	SC (umhos/cm at 25 C) (Fld)	2610	2540	2540	2560	2550	2570
	Water Temperature (C) (Fld)	12.3	12.3	12.3	12.4	12.3	12.4

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-3	STW-3	STW-3	STW-3	STW-3	STW-3
Water	SAMPLE DATE	2/5/2002	2/12/2002	2/13/2002	2/14/2002	2/15/2002	2/19/2002
	SAMPLE TIME	14:00	10:30	15:05	14:40	10:00	14:10
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L020075007	L020096005	L020096008	L020101003	L020101008	L020110006
	SAMPLE NUMBER	EHST-0202-406	EHST-0202-504	EHST-0202-602	EHST-0202-702	EHST-0202-802	EHST-0202-905
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						
Common Ions: ppm unless noted							
	Bicarbonate (HCO3)	231	206	207	198	188	166
	Carbonate As CO3	<1	<1	<1	<1	<1	<1
	Sulfate (SO4)	963	902	880	891	906	971
	Total Alkalinity As CaCO3	189	169	170	162	154	136
Metals: ppm unless noted							
	Arsenic (As) (DIS)	22	21	20	21	20	22
	Arsenic +3	7.2					7
	Arsenic +5	15					14
	Cadmium (Cd) (DIS)	<0.001					<0.001
	Copper (Cu) (DIS)						0.01
	Iron (Fe +2)				<0.01	<0.01	
	Iron (Fe) (DIS)	<0.02	<0.02	<0.02	<0.02	<0.02	0.04
	Lead (Pb) (DIS)	<0.005					<0.005
	Manganese (Mn) (DIS)	1.7					1.4
	Zinc (Zn) (DIS)	0.1					0.1
Physical/Fld-Lab: ppm unless noted							
	Iron (Fe) (Fld)		<0.01	<0.01			
	Oxygen (O) (DIS) (Fld)	6.8	6.3	5.7	7.4	7.8	7.2
	pH						7.6
	Depth To Water Level (ft)	34	34.3	34.2	34.5	34.4	34.4
	pH (Fld)	7.05	7.2	7.2	7.3	7.3	7.3
	SC (umhos/cm at 25 C) (Fld)	2530	2600	2500	2440	2550	2590
	SC (umhos/cm at 25 C)						2580
	Water Temperature (C) (Fld)	12.5	12.1	12.5	12.1	12.2	12.4

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-3	STW-3	STW-3	STW-3	STW-3	STW-3
Water	SAMPLE DATE	2/22/2002	2/27/2002	4/19/2002	5/10/2002	6/6/2002	7/17/2002
	SAMPLE TIME	11:00	12:55	15:10	00:00	15:45	14:50
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	ASARCO	TSC-SLC	TSC-SLC
	LAB NUMBER	L020118006	L020142008	L020278008	205103	L020426007	L020591003
	SAMPLE NUMBER	EHST-0202-105	EHST-0202-207	EHST-0204-107	EHST-0205-103A	EHST-0206-106	EHST-0207-103
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						
Common Ions: ppm unless noted							
	Bicarbonate (HCO3)	165	171	176		173	174
	Calcium (Ca) (DIS)					97	
	Carbonate As CO3	<1	<1	<1		<1	<1
	Chloride (Cl)					199	
	Magnesium (Mg) (DIS)					23	
	Potassium (K) (DIS)					15	
	Sodium (Na) (DIS)					508	
	Sulfate (SO4)	1010	913	956		1098	983
	Total Alkalinity As CaCO3	135	140	144		142	143
Metals: ppm unless noted							
	Aluminum (Al) (DIS)					<0.05	
	Arsenic (As) (DIS)	21	21	21		20	17
	Arsenic +3			7.4		13	13
	Arsenic +5			13		6	4
	Cadmium (Cd) (DIS)			<0.001		<0.001	
	Copper (Cu) (DIS)					0.008	
	Iron (Fe) (DIS)	<0.02	<0.02	<0.02		<0.02	<0.02
	Lead (Pb) (DIS)			<0.005		<0.005	
	Manganese (Mn) (DIS)			0.8		0.8	
	Zinc (Zn) (DIS)			0.08		0.08	
Other: ppm unless noted							
	Silicon+Silica (Si+SiO2)					24	
Physical/Fld-Lab: ppm unless noted							
	Oxygen (O) (DIS) (Fld)	7.3	7.7	7.6		7.5	8.5
	pH					7.5	
	Depth To Water Level (ft)	34.5	35.8	35.4	35.4	34.6	31.7
	pH (Fld)	7.4	7.2	7.7		7.5	7.4
	SC (umhos/cm at 25 C) (Fld)	2550	2490	2600		2670	2470
	SC (umhos/cm at 25 C)					2810	
	Total Suspended Solids					59	
	TDS (Measured at 180 C)					1931	
	Water Temperature (C) (Fld)	12.7	12.2	13		15.3	12.4

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-3	STW-3	STW-3	STW-3	STW-3	STW-3
Water	SAMPLE DATE	7/24/2002	7/31/2002	8/8/2002	8/14/2002	8/22/2002	8/28/2002
	SAMPLE TIME	13:45	12:15	16:50	14:00	12:00	14:15
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L020594005	L020606003	L020642003	L020650003	L020686003	L020705004
	SAMPLE NUMBER	EHST-0207-304	EHST-0207-502	EHST-0208-110	EHST-0208-302	EHST-0208-503	EHST-0208-603
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						
Common Ions: ppm unless noted							
	Bicarbonate (HCO3)	168	168	167	159	142	139
	Carbonate As CO3	<1	<1	<1	<1	<1	<1
	Sulfate (SO4)	1010	944	966	917	1182	1007
	Total Alkalinity As CaCO3	138	138	137	130	116	114
Metals: ppm unless noted							
	Arsenic (As) (DIS)	17	16	15	16	17	18
	Arsenic +3	13	13	12	14	13	13
	Arsenic +5	5	3	4	1	4	5
	Cadmium (Cd) (DIS)	<0.001					
	Iron (Fe) (DIS)	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
	Lead (Pb) (DIS)	<0.005					
	Manganese (Mn) (DIS)	1.2					
	Zinc (Zn) (DIS)	0.1					
Physical/Fld-Lab: ppm unless noted							
	Oxygen (O) (DIS) (Fld)	10	9.9	10	6.2	6.3	6.2
	Depth To Water Level (ft)		29.9	30.3	30.07	30.2	30.2
	pH (Fld)	7.4	6.9	7.3	7	7.2	7.4
	SC (umhos/cm at 25 C) (Fld)	2140	2670	2930	2300	3290	2280
	Water Temperature (C) (Fld)	12.6	13.3	12.2	13.2	12.5	12.7

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-3	STW-3	STW-3	STW-3	STW-3	STW-3
Water	SAMPLE DATE	9/5/2002	9/17/2002	9/19/2002	9/26/2002	10/4/2002	10/23/2002
	SAMPLE TIME	11:30	11:00	12:25	16:05	15:00	13:30
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L020731004	L020869003	L020785005	L020829005	L020845003	L020888003
	SAMPLE NUMBER	EHST-0209-103	EHST-0210-302	EHST-0209-404	EHST-0209-604	EHST-0210-104	EHST-0210-402
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						
Common Ions: ppm unless noted							
	Bicarbonate (HCO3)	161	176	167	165	168	171
	Carbonate As CO3	<1	<1	<1	<1	<1	<1
	Sulfate (SO4)	1148	976	1134	1041	1005	932
	Total Alkalinity As CaCO3	132	144	137	135	138	140
Metals: ppm unless noted							
	Arsenic (As) (DIS)	15	15	15	15	15	15
	Arsenic +3	11	16	11	15	10	15
	Arsenic +5	4	<0.005	4	<0.005	5	<0.005
	Iron (Fe) (DIS)	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Physical/Fld-Lab: ppm unless noted							
	Oxygen (O) (DIS) (Fld)	6.07	7.3	6.8	6	6.05	6.9
	Depth To Water Level (ft)	30.2	31	31.3	30.4	30.8	31.2
	pH (Fld)	7.2	7.3	7.2	7.2	6.8	7.4
	SC (umhos/cm at 25 C) (Fld)	2210	2700	2680	2490	1523	2640
	TDS (Measured at 180 C)	2016					
	Water Temperature (C) (Fld)	12.4	11.8	12.5	12.2	12.3	11.9

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-3	STW-3	STW-3	STW-3	STW-3	STW-3
Water	SAMPLE DATE	10/31/2002	11/13/2002	12/17/2002	6/2/2003	10/30/2003	5/13/2004
	SAMPLE TIME	14:40	11:50	00:00	00:00	00:00	13:17
	LAB	TSC-SLC	TSC-SLC	ASARCO	ASARCO	TSC-SLC	ASARCO
	LAB NUMBER	L020915003	L020943004	EHST-0212-104	0306-229	AEH-0310-462	AEH-0405-243
	SAMPLE NUMBER	EHST-0210-502	EHC-0211-214	EHST-0212-104	AEH-0306-229	AEH-0310-462	AEH-0405-243
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION					SWL Only Req	SWL Only Req
	REMARKS						

Common Ions: ppm unless noted

Bicarbonate (HCO3)	163	188
Calcium (Ca) (DIS)		120
Carbonate As CO3	<1	<1
Chloride (Cl)		182
Magnesium (Mg) (DIS)		27
Potassium (K) (DIS)		17
Sodium (Na) (DIS)		453
Sulfate (SO4)	957	1065
Total Alkalinity As CaCO3	134	154

Metals: ppm unless noted

Aluminum (Al) (DIS)		<0.05
Arsenic (As) (DIS)	15	15
Arsenic +3	16	6.1
Arsenic +5	<0.005	8.9
Cadmium (Cd) (DIS)		<0.001
Copper (Cu) (DIS)		0.006
Iron (Fe) (DIS)	<0.02	<0.02
Lead (Pb) (DIS)		<0.005
Manganese (Mn) (DIS)		0.9
Zinc (Zn) (DIS)		0.06

Other: ppm unless noted

Silicon+Silica (Si+SiO2)		24
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Physical/Fld-Lab: ppm unless noted

Oxygen (O) (DIS) (Fld)	5.9	5.1				
pH		7.5				
Depth To Water Level (ft)	31.5	31.9	32.83	32.7	31.65	33.24
pH (Fld)	7.5	7.2				
SC (umhos/cm at 25 C) (Fld)	2880	2620				
SC (umhos/cm at 25 C)		2680				
Total Suspended Solids		6.2				
TDS (Measured at 180 C)		1925				
Water Temperature (C) (Fld)	11.3	12.2				

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-4	STW-4	STW-4	STW-4	STW-4	STW-4
Water	SAMPLE DATE	5/10/2000	5/18/2000	5/30/2000	6/6/2000	6/13/2000	6/13/2000
	SAMPLE TIME	15:20	11:30	11:10	10:50	12:35	12:35
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L000720005	L000759003	L000825002	L000882003	L000910000	L000910007
	SAMPLE NUMBER	EHST-0005-104	EHST-0005-112	EHST-0005-121	EHST-0006-102	EHST-0006-205	EHST-0006-206
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						Field Duplicate

Common Ions: ppm unless noted

Bicarbonate (HCO3)	251
Calcium (Ca) (DIS)	70
Carbonate As CO3	<1
Chloride (Cl)	182
Magnesium (Mg) (DIS)	18
Potassium (K) (DIS)	13
Sodium (Na) (DIS)	458
Sulfate (SO4)	844

Metals: ppm unless noted

Arsenic (As) (DIS)	37	40	37	36	32	32
Arsenic +3	37			45		
Arsenic +5	3.1			4		
Cadmium (Cd) (DIS)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Iron (Fe) (DIS)	0.5	0.6	0.7	0.6	0.7	0.7
Lead (Pb) (DIS)	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Manganese (Mn) (DIS)	3.2	3.4	3.4	3.5	3.5	3.4
Zinc (Zn) (DIS)	0.3	0.3	0.3	0.3	0.3	0.3

Physical/Fld-Lab: ppm unless noted

Iron (Fe) (Fld)	0.5	0.6	0.7	0.7	0.7	
Iron (Fe+2) (Fld)	0.7	0.6	0.6	0.7	0.7	
Oxygen (O) (DIS) (Fld)	1.3	1	0.9	1	1.5	1.5
pH	7.5					
Depth To Water Level (ft)	32.8	32.8	32.6	32.5	32.2	
Eh (millivolts)	216	204	212	206	191	191
pH (Fld)	6.8	7	6.8	6.8	6.8	6.8
SC (umhos/cm at 25 C) (Fld)	2670	2670	2750	2780	2930	2950
SC (umhos/cm at 25 C)	2650					
Water Temperature (C) (Fld)	12.3	13.7	12.6	13.5	13.1	13.1

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-4	STW-4	STW-4	STW-4	STW-4	STW-4
Water	SAMPLE DATE	6/21/2000	6/21/2000	6/29/2000	7/13/2000	7/13/2000	7/24/2000
	SAMPLE TIME	14:10	14:12	12:55	13:00	13:15	13:00
	LAB	TSC-SLC	PEAK	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L000964008	P000343	L001003006	L001116006	L001116007	L001190003
	SAMPLE NUMBER	EHST-0006-307	EHST-0006-307	EHST-0006-405	EHST-0007-105	EHST-0007-106	EHST-0007-202
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS		Split			Field Duplicate	
Common Ions: ppm unless noted							
	Bicarbonate (HCO3)	195	194				
	Calcium (Ca) (DIS)	72	71.5				
	Carbonate As CO3	<1	<1				
	Chloride (Cl)	195	149				
	Magnesium (Mg) (DIS)	19	20.9				
	Potassium (K) (DIS)	11	17.2				
	Sodium (Na) (DIS)	476	428				
	Sulfate (SO4)	893	626				
Metals: ppm unless noted							
	Arsenic (As) (DIS)	28	25.5	25	27	26	25
	Arsenic +3	17	21.1	16	11 J	8.3 J	6.5
	Arsenic +5	9.9	4.5	13	19	17	19
	Cadmium (Cd) (DIS)	<0.001	<0.001				
	Iron (Fe) (DIS)	0.4	0.5				
	Lead (Pb) (DIS)	<0.005	<0.005				
	Manganese (Mn) (DIS)	3.3	3.4				
	Zinc (Zn) (DIS)	0.3	0.3				
Physical/Fld-Lab: ppm unless noted							
	Iron (Fe) (Fld)	0.5		0.4	0.2		0.2
	Iron (Fe+2) (Fld)	0.4		0.3	0.1		0.1
	Oxygen (O) (DIS) (Fld)	1		0.9	1.9	1.9	2.5
	pH	7.2	6.8				
	Depth To Water Level (ft)	31.7		31.5	31.4	31.4	31.5
	Eh (millivolts)	196		201	202	202	230
	pH (Fld)	6.8		6.8	7.07	7.08	6.6
	SC (umhos/cm at 25 C) (Fld)	2440		2680	2710	2660	2850
	SC (umhos/cm at 25 C)	2650	2690				
	Water Temperature (C) (Fld)	13.8		14.5	14.8	14.8	14.5

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-4	STW-4	STW-4	STW-4	STW-4	STW-4
Water	SAMPLE DATE	8/3/2000	8/16/2000	8/31/2000	9/13/2000	10/3/2000	11/3/2000
	SAMPLE TIME	11:50	12:45	10:35	14:15	11:20	12:45
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L001239007	L001333007	L001441003	L001513008	L001649003	L001861004
	SAMPLE NUMBER	EHST-0008-106	EHST-0008-206	EHST-0008-302	EHST-0009-107	EHST-0010-102	EHST-0011-103
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						

Common Ions: ppm unless noted

Bicarbonate (HCO3)	171
Calcium (Ca) (DIS)	73
Carbonate As CO3	<1
Chloride (Cl)	185
Magnesium (Mg) (DIS)	18
Potassium (K) (DIS)	12
Sodium (Na) (DIS)	462
Sulfate (SO4)	1006 J

Metals: ppm unless noted

Arsenic (As) (DIS)	28	29	30	32	36	37
Arsenic +3	7.8	11	12	17	21	27
Arsenic +5	25 J	20	17	16	13	11
Cadmium (Cd) (DIS)	<0.001					
Iron (Fe) (DIS)	0.2					
Lead (Pb) (DIS)	<0.005					
Manganese (Mn) (DIS)	3					
Zinc (Zn) (DIS)	0.2					

Physical/Fld-Lab: ppm unless noted

Iron (Fe) (Fld)		0.3	0.2	0.0	0.2	
Iron (Fe+2) (Fld)	0.09	0.2	0.2	0.0	0.2	0.2
Oxygen (O) (DIS) (Fld)	1.7	0.8	0.9	0.9	0.6	0.7
pH	7.2					
Depth To Water Level (ft)	31.5	31.6	31.9	32.2	32.7	32.2
Eh (millivolts)	247	221	224	353		244
pH (Fld)	7	7.1	7.09	7.1	6.7	6.9
SC (umhos/cm at 25 C) (Fld)	2730	2330	2830	2770	2410	2620
SC (umhos/cm at 25 C)	2710					
Water Temperature (C) (Fld)	14.4	13.9	13.5	14	12.3	12.2

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-4	STW-4	STW-4	STW-4	STW-4	STW-4
Water	SAMPLE DATE	12/20/2000	2/7/2001	5/14/2001	9/26/2001	10/19/2001	11/2/2001
	SAMPLE TIME	11:15	11:45	16:00	10:00	12:20	10:27
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	HYDRO	HYDRO
	LAB NUMBER	L002044004	L010183007	L010699012	L011367002	FIELD ONLY	FIELD ONLY
	SAMPLE NUMBER	EHST-0012-103	EHST-0102-106	EHST-0105-199	EHST-0109-101	EHST-0110-103	EHST-0111-104
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						
Common Ions: ppm unless noted							
	Bicarbonate (HCO3)	273		222	217		
	Calcium (Ca) (DIS)	76		87			
	Carbonate As CO3	<1			<1		
	Chloride (Cl)	156		246			
	Magnesium (Mg) (DIS)	18		21			
	Potassium (K) (DIS)	13		14			
	Sodium (Na) (DIS)	571		495			
	Sulfate (SO4)	934		1088	911		
	Total Alkalinity As CaCO3	224		182	178		
Metals: ppm unless noted							
	Aluminum (Al) (DIS)			<0.05			
	Arsenic (As) (DIS)	37	33	34	33		
	Arsenic +3	26	30	39	35		
	Arsenic +5	8.6	8.6	<0.005	<0.005		
	Cadmium (Cd) (DIS)	0.002		0.002	<0.001		
	Copper (Cu) (DIS)	0.006		0.01			
	Iron (Fe) (DIS)	0.2	0.2	0.2	0.2		
	Lead (Pb) (DIS)	0.007		<0.005	<0.005		
	Manganese (Mn) (DIS)	3.1		3.3	3.1		
	Zinc (Zn) (DIS)	0.2		0.2	0.2		
Other: ppm unless noted							
	Silicon+Silica (Si+SiO2)			27			
Physical/Fld-Lab: ppm unless noted							
	Iron (Fe) (Fld)				0.2	0.1	0.2
	Iron (Fe+2) (Fld)	0.2			0.1	0.1	0.08
	Oxygen (O) (DIS) (Fld)	0.9	1.02	0.8	0.2	0.03	0.3
	pH	7.6		7.5			
	Depth To Water Level (ft)	33.1	33.8	33.7	29.7	30.6	30.7
	Eh (millivolts)	253	249	362	250	273	
	pH (Fld)	7.05	7.4	7.5	6.8	6.9	6.7
	SC (umhos/cm at 25 C) (Fld)	2830	2760	2130	2820	2770	2740
	SC (umhos/cm at 25 C)	2820		2860			
	Total Suspended Solids			76			
	TDS (Measured at 180 C)	2001		2045			
	Water Temperature (C) (Fld)	12.3	11.3	14.4	12.5	12.3	12.3

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\VS_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-4	STW-4	STW-4	STW-4	STW-4	STW-4
Water	SAMPLE DATE	11/20/2001	12/7/2001	12/14/2001	12/19/2001	12/27/2001	1/10/2002
	SAMPLE TIME	00:00	12:00	10:55	12:10	12:45	10:50
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L011587004	L011626004	L011652002	L011661004	L011677002	L020025004
	SAMPLE NUMBER	EHST-0111-203	EHST-0112-203	EHST-0112-301	EHST-0112-403	EHST-0112-501	EHST-0201-103
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RJ	RJ	RJ	RJ	RJ	RJ
	DESCRIPTION						
	REMARKS						

Common Ions: ppm unless noted

Bicarbonate (HCO3)	206	228	229	237	220	248
Carbonate As CO3	<1	<1	<1	<1	<1	<1
Sulfate (SO4)	752	753	884	970	780	798
Total Alkalinity As CaCO3	169	187	188	194	180	203

Metals: ppm unless noted

Arsenic (As) (DIS)	34	32	32	33	31	32
Arsenic +3	17	19		17		17
Arsenic +5	17	15		17		15
Cadmium (Cd) (DIS)		<0.001		<0.001		0.004
Iron (Fe) (DIS)		0.2	0.1	0.1	0.1	0.2
Lead (Pb) (DIS)		<0.005		<0.005		<0.005
Manganese (Mn) (DIS)		3.1		3		3
Zinc (Zn) (DIS)		0.3		0.3		0.2

Physical/Fld-Lab: ppm unless noted

Iron (Fe) (Fld)	0.1					
Iron (Fe+2) (Fld)	0.08		0.02			
Oxygen (O) (DIS) (Fld)	0.1	0.3	0.3	0.3	0.3	0.2
Depth To Water Level (R)	31.2	31.7	31.9	32.07	34.3	32.7
pH (Fld)	6.6	6.9	6.8	6.7	6.8	6.8
SC (umhos/cm at 25 C) (Fld)	2720	2870	2900	2760	2710	2300
Water Temperature (C) (Fld)	12.4	12.2	12.1	12.3	12.2	12.4

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-4	STW-4	STW-4	STW-4	STW-4	STW-4
Water	SAMPLE DATE	1/16/2002	1/23/2002	2/5/2002	2/19/2002	2/27/2002	4/19/2002
	SAMPLE TIME	12:00	11:10	13:30	14:40	12:30	14:15
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L020027004	L020042004	L020075004	L020110009	L020142005	L020278006
	SAMPLE NUMBER	EHST-0201-203	EHST-0201-303	EHST-0202-403	EHST-0202-908	EHST-0202-204	EHST-0204-105
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						
Common Ions: ppm unless noted							
	Bicarbonate (HCO3)	240	229	226	222	217	211
	Carbonate As CO3	<1	<1	<1	<1	<1	<1
	Sulfate (SO4)	843	867	1008	904	1112	988
	Total Alkalinity As CaCO3	197	188	185	182	178	173
Metals: ppm unless noted							
	Arsenic (As) (DIS)	32	32	33	30	30	28
	Arsenic +3		16	17	16		11
	Arsenic +5		17	15	14		17
	Cadmium (Cd) (DIS)		0.001	<0.001	<0.001		<0.001
	Copper (Cu) (DIS)				0.02		
	Iron (Fe) (DIS)	0.2	0.2	0.2	0.1	0.2	0.06
	Lead (Pb) (DIS)		<0.005	<0.005	<0.005		<0.005
	Manganese (Mn) (DIS)		3	3.1	3.1		2.8
	Zinc (Zn) (DIS)		0.2	0.2	0.2		0.2
Physical/Fid-Lab: ppm unless noted							
	Oxygen (O) (DIS) (Fld)	0.2	0.2	0.9	0.6	0.2	0.4
	pH				7.4		
	Depth To Water Level (ft)	32.8	33	33.3	33.8	34.2	34.7
	pH (Fld)	6.7	6.5	6.8	7.06	6.8	7
	SC (umhos/cm at 25 C) (Fld)	2690	2700	2710	2720	2900	2950
	SC (umhos/cm at 25 C)				2770		
	Water Temperature (C) (Fld)	12.3	12.3	12.3	12.3	12.4	12.8

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-4	STW-4	STW-4	STW-4	STW-4	STW-4
Water	SAMPLE DATE	5/10/2002	6/6/2002	7/17/2002	7/24/2002	7/31/2002	8/8/2002
	SAMPLE TIME	14:55	13:30	15:10	13:15	14:00	16:15
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L020364004	L020426002	L020591004	L020594004	L020606005	L020642001
	SAMPLE NUMBER	EHST-0205-103	EHST-0206-101	EHST-0207-104	EHST-0207-303	EHST-0207-504	EHST-0208-108
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						
Common Ions: ppm unless noted							
	Bicarbonate (HCO3)	200	190	168	171	166	168
	Calcium (Ca) (DIS)		78				
	Carbonate As CO3	<1	<1	<1	<1	<1	<1
	Chloride (Cl)		199				
	Magnesium (Mg) (DIS)		18				
	Potassium (K) (DIS)		13				
	Sodium (Na) (DIS)		549				
	Sulfate (SO4)	905 J	1081	895	990	1123	1140
	Total Alkalinity As CaCO3	164	156	138	140	136	138
Metals: ppm unless noted							
	Aluminum (Al) (DIS)		<0.05				
	Arsenic (As) (DIS)	26	25	24	27	25	24
	Arsenic +3	8.8	13	21	19	19	23
	Arsenic +5	18	13	3	8	8	2
	Cadmium (Cd) (DIS)	<0.001	<0.001		<0.001		
	Copper (Cu) (DIS)		0.006				
	Iron (Fe) (DIS)	0.05	0.07	0.04	0.03	0.05	0.05
	Lead (Pb) (DIS)	<0.005	<0.005		<0.005		
	Manganese (Mn) (DIS)	2.6	2.7		2.4		
	Zinc (Zn) (DIS)	0.2	0.2		0.2		
Other: ppm unless noted							
	Silicon+Silica (Si+SiO2)		25				
Physical/Fld-Lab: ppm unless noted							
	Oxygen (O) (DIS) (Fld)	0.9	0.4	0.9	0.9	1.3	1
	pH		7				
	Depth To Water Level (ft)	34.8	33.9	30.4		29.6	29.6
	pH (Fld)	7.04	6.8	7	6.9	6.6	6.8
	SC (umhos/cm at 25 C) (Fld)	2490	2720	2480	2210	2900	3030
	SC (umhos/cm at 25 C)		2770				
	Total Suspended Solids		4.6				
	TDS (Measured at 180 C)		1970				
	Water Temperature (C) (Fld)	13	13.6	12.7	13.1	14.1	12.6

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-4	STW-4	STW-4	STW-4	STW-4	STW-4
Water	SAMPLE DATE	8/14/2002	8/22/2002	8/28/2002	9/4/2002	9/19/2002	10/4/2002
	SAMPLE TIME	14:30	11:30	13:35	15:20	11:55	14:00
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L020650005	L020686004	L020705005	L020731005	L020785003	L020845001
	SAMPLE NUMBER	EHST-0208-304	EHST-0208-504	EHST-0208-604	EHST-0209-104	EHST-0209-402	EHST-0210-100
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						
Common Ions: ppm unless noted							
	Bicarbonate (HCO3)	166	161	156	173	178	193
	Carbonate As CO3	<1	<1	<1	<1	<1	<1
	Sulfate (SO4)	960	1060	962	1126	1060	984
	Total Alkalinity As CaCO3	136	132	128	142	146	158
Metals: ppm unless noted							
	Arsenic (As) (DIS)	24	15	16	25	24	25
	Arsenic +3	20	15	12	18	22	17
	Arsenic +5	5	1	4	7	2	7
	Iron (Fe) (DIS)	0.04	<0.02	<0.02	0.04	0.03	0.02
Physical/Fld-Lab: ppm unless noted							
	Oxygen (O) (DIS) (Fld)	0.6	0.8	1.4	0.9	1	1.4
	Depth To Water Level (R)	29.4	29.5	29.5	29.5	30.3	30.03
	pH (Fld)	6.8	6.6	6.8	6.9	6.7	6.8
	SC (umhos/cm at 25 C) (Fld)	2430	3330	2500	2070	2810	2520
	TDS (Measured at 180 C)				2068		
	Water Temperature (C) (Fld)	13.1	12.5	12.5	12.7	12.8	12.8

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-4	STW-4	STW-4	STW-4	STW-4	STW-4
Water	SAMPLE DATE	10/17/2002	10/23/2002	10/31/2002	11/13/2002	12/17/2002	6/2/2003
	SAMPLE TIME	10:30	13:00	14:15	11:15	00:00	11:15
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	ASARCO	TSC-SLC
	LAB NUMBER	L020869001	L020888001	L020915001	L020943001	EHST-0212-105	L030245006
	SAMPLE NUMBER	EHST-0210-300	EHST-0210-400	EHST-0210-500	EHC-0211-215	EHST-0212-105	AEH-0306-168
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						
Common Ions: ppm unless noted							
	Bicarbonate (HCO3)	195	193	195	205		228
	Calcium (Ca) (DIS)				84		70
	Carbonate As CO3	<1	<1	<1	<1		<2
	Chloride (Cl)				182		168
	Magnesium (Mg) (DIS)				19		18
	Potassium (K) (DIS)				14		13
	Sodium (Na) (DIS)				535		449
	Sulfate (SO4)	984	1006	943	1058		851
	Total Alkalinity As CaCO3	160	158	160	168		187
Metals: ppm unless noted							
	Aluminum (Al) (DIS)				<0.05		
	Arsenic (As) (DIS)	25	26	24	24		19
	Arsenic +3	22	24	24	14		25
	Arsenic +5	3	2	<0.005	10		<0.005
	Cadmium (Cd) (DIS)				<0.001		<0.001
	Copper (Cu) (DIS)				0.006		0.01 J
	Iron (Fe) (DIS)	<0.02	<0.02	<0.02	<0.02		0.09
	Lead (Pb) (DIS)				<0.005		<0.005
	Manganese (Mn) (DIS)				1.9		2.7
	Zinc (Zn) (DIS)				0.2		0.2
Other: ppm unless noted							
	Silicon+Silica (Si+SiO2)				25		
Physical/Fld-Lab: ppm unless noted							
	Oxygen (O) (DIS) (Fld)	1.3	1.5	1.2	0.8		0.3
	pH				7.5		7.2
	Depth To Water Level (ft)	30.3	30.5	30.8	31.2	32.17	32.05
	pH (Fld)	6.7	6.6	6.8	6.5		6.3
	SC (umhos/cm at 25 C) (Fld)	2770	2740	2320	2610		2450
	SC (umhos/cm at 25 C)				2870		2520
	Total Suspended Solids				2.8		46
	TDS (Measured at 180 C)				2024		1718
	Salinity (G/KG) (Fld)						1.1
	Turbidity (NTU) (Fld)						4
	Water Temperature (C) (Fld)	11.8	12	11.5	12.1		12.5

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-4	STW-4	STW-5	STW-5	STW-5
Water	SAMPLE DATE	10/30/2003	5/20/2004	5/10/2000	5/18/2000	5/30/2000
	SAMPLE TIME	10:30	10:20	14:20	11:10	11:45
	LAB	TSC-SLC	ELI	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L030605019	H04050133-003	L000720004	L000759002	L000825003
	SAMPLE NUMBER	AEH-0310-442	AEH-0405-126	EHST-0005-103	EHST-0005-111	EHST-0005-122
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI
	DESCRIPTION					
	REMARKS					

Common Ions: ppm unless noted

Bicarbonate (HCO3)	250	271
Calcium (Ca) (DIS)	74	92
Carbonate As CO3	<2	<1
Chloride (Cl)	133	187
Magnesium (Mg) (DIS)	18	23
Potassium (K) (DIS)	12	12
Sodium (Na) (DIS)	406	417
Sulfate (SO4)	736	875
Total Alkalinity As CaCO3	205	

Common Ions (mg/L): ppm unless noted

Bicarbonate (HCO3)	210
Calcium (Ca) (DIS)	83
Chloride (Cl)	110
Magnesium (Mg) (DIS)	19
Potassium (K) (DIS)	14
Sodium (Na) (DIS)	358
Sulfate (SO4)	890
Total Alkalinity As CaCO3	180

Metals: ppm unless noted

Arsenic (As) (DIS)	19	17	19	20
Arsenic +3	8.5	8.7		
Arsenic +5	12	9.8		
Cadmium (Cd) (DIS)	<0.001	<0.001	0.002	<0.001
Copper (Cu) (DIS)	0.007			
Iron (Fe) (DIS)	0.08	<0.05	<0.05	<0.02
Lead (Pb) (DIS)	<0.005	<0.005	<0.005	<0.005
Manganese (Mn) (DIS)	3	2.7	2.8	2.5
Zinc (Zn) (DIS)	0.2	0.2	0.3	0.3

Metals (mg/L): ppm unless noted

Arsenic (As) (DIS)	11.23
Arsenic +3	3.1 J
Arsenic +5	16 J
Cadmium (Cd) (DIS)	<0.001
Copper (Cu) (DIS)	0.005
Iron (Fe) (DIS)	0.25
Lead (Pb) (DIS)	<0.005
Manganese (Mn) (DIS)	3.58
Zinc (Zn) (DIS)	0.28

Physical/Fld-Lab: ppm unless noted

Iron (Fe) (Fld)	0.1	0.05	0.04
Iron (Fe+2) (Fld)	<0.1	0.03	0.01

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB
ASARCO, East Helena Plant

Sample Matrix	STATION	STW-4	STW-4	STW-5	STW-5	STW-5
Water	SAMPLE DATE	10/30/2003	5/20/2004	5/10/2000	5/18/2000	5/30/2000
	SAMPLE TIME	10:30	10:20	14:20	11:10	11:45
	LAB	TSC-SLC	ASARCO	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L030605019	H04050133-003	L000720004	L000759002	L000825003
	SAMPLE NUMBER	AEH-0310-442	AEH-0405-126	EHST-0005-103	EHST-0005-111	EHST-0005-122
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI
	DESCRIPTION					
	REMARKS					

Physical/Fld-Lab: ppm unless noted

	STW-4	STW-4	STW-5	STW-5	STW-5
Oxygen (O) (DIS) (Fld)	0.27		1.4	1.2	1.1
Oxygen (O) (DIS) (Fld) (DIS)		0.29			
pH	7.8	7.1	7.8		
Depth To Water Level (ft)	31.02	32.56	32.7	32.6	32.5
Eh (millivolts)			316	309	299
pH (Fld)	6.28	6.23	6.7	6.8	6.8
SC (umhos/cm at 25 C) (Fld)	2370	2210	2720	2620	2650
SC (umhos/cm at 25 C)	2400	2380	2590		
Total Suspended Solids	20 J	11			
TDS (Measured at 180 C)	1652	1490			
Salinity (G/KG) (Fld)	1.1	10			
Turbidity (NTU) (Fld)	53	0.0			
Water Temperature (C) (Fld)	11.9	12.7	12.1	13.5	12.6

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-5	STW-5	STW-5	STW-5	STW-5	STW-5
Water	SAMPLE DATE	6/6/2000	6/13/2000	6/21/2000	6/29/2000	7/13/2000	7/24/2000
	SAMPLE TIME	10:15	10:30	11:20	10:35	10:20	12:30
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L000882002	L000910002	L000964004	L001003002	L001116002	L001190002
	SAMPLE NUMBER	EHST-0006-101	EHST-0006-201	EHST-0006-303	EHST-0006-401	EHST-0007-101	EHST-0007-201
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						

Common Ions: ppm unless noted

Bicarbonate (HCO3)	146
Calcium (Ca) (DIS)	79
Carbonate As CO3	<1
Chloride (Cl)	184
Magnesium (Mg) (DIS)	21
Potassium (K) (DIS)	11
Sodium (Na) (DIS)	436
Sulfate (SO4)	882

Metals: ppm unless noted

Arsenic (As) (DIS)	17	18	18	17	20	19
Arsenic +3	9 J		4.6	3	2 J	1.2
Arsenic +5	14		13	14	17	17
Cadmium (Cd) (DIS)	<0.001	<0.001	<0.001			
Iron (Fe) (DIS)	<0.05	<0.02	<0.03			
Lead (Pb) (DIS)	<0.005 J	<0.005	<0.005			
Manganese (Mn) (DIS)	2.4	2.3	2.2			
Zinc (Zn) (DIS)	0.2	0.2	0.2			

Physical/Fid-Lab: ppm unless noted

Iron (Fe) (Fid)	0.03	0.03	0.02	<0.01	0.01	0.03
Iron (Fe+2) (Fid)	0.02	<0.01	<0.01	<0.01	<0.01	0.01
Oxygen (O) (DIS) (Fid)	1.2	1.3	1.8	1.6	3.3	3.9
pH			7.2			
Depth To Water Level (ft)	32.3	32.2	31.7	31.4	31.3	31.3
Eh (millivolts)	332	351	406	396	374	388
pH (Fid)	6.8	6.6	6.6	6.7	6.7	6.6
SC (umhos/cm at 25 C) (Fid)	2650	2740	2430	2550	2620	2690
SC (umhos/cm at 25 C)			2510			
Water Temperature (C) (Fid)	13.2	12.5	13.4	15.1	13.9	14.1

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-3	STW-3	STW-5	STW-5	STW-5	STW-5
Water	SAMPLE DATE	8/3/2000	8/16/2000	8/31/2000	9/13/2000	10/3/2000	12/20/2000
	SAMPLE TIME	09:45	10:50	11:15	11:50	13:35	13:00
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L001239003	L001333003	L001441004	L001513003	L001649007	L002044005
	SAMPLE NUMBER	EHST-0008-102	EHST-0008-202	EHST-0008-303	EHST-0009-102	EHST-0010-106	EHST-0012-104
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						

Common Ions: ppm unless noted

Bicarbonate (HCO3)	109						272
Calcium (Ca) (DIS)	81						93
Carbonate As CO3	<1						<1
Chloride (Cl)	195						148
Magnesium (Mg) (DIS)	19						23
Potassium (K) (DIS)	11						13
Sodium (Na) (DIS)	413						543
Sulfate (SO4)	1026 J						1016
Total Alkalinity As CaCO3							223

Metals: ppm unless noted

Arsenic (As) (DIS)	19	20	20	22	23	19
Arsenic +3	1.2	1	1	1.1	1.7	3.8
Arsenic +5	19 J	19	19	20	20	15
Cadmium (Cd) (DIS)	<0.001					0.001
Copper (Cu) (DIS)						0.008
Iron (Fe) (DIS)	0.01 U					<0.02
Lead (Pb) (DIS)	<0.005					<0.005
Manganese (Mn) (DIS)	1.8					2.1
Zinc (Zn) (DIS)	0.2					0.2

Physical/Fld-Lab: ppm unless noted

Iron (Fe) (Fld)		0.04	0.04		0.04	
Iron (Fe+2) (Fld)	<0.01	0.03	0.01		0.02	0.02
Oxygen (O) (DIS) (Fld)	4.1	2.04	1.2	1.2	0.9	1.1
pH	7.2					7.5
Depth To Water Level (R)	31.4	31.4	31.7	32.06	32.6	33
Eh (millivolts)	427	397	339	401		355
pH (Fld)	6.8	7.1	7.2	7.1	6.7	7.3
SC (umhos/cm at 25 C) (Fld)	2690	2260	2770	3070	2450	2930
SC (umhos/cm at 25 C)	2610					2860
TDS (Measured at 180 C)						2051
Water Temperature (C) (Fld)	13.4	13.6	13.1	14.2	12.6	9.7

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-5	STW-5	STW-5	STW-5	STW-5	STW-5
Water	SAMPLE DATE	2/7/2001	5/14/2001	9/26/2001	10/19/2001	11/2/2001	11/20/2001
	SAMPLE TIME	12:00	16:15	10:15	12:40	10:45	00:00
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	HYDRO	HYDRO	TSC-SLC
	LAB NUMBER	L010183008	L010699009	L011367003	FIELD ONLY	FIELD ONLY	L011587006
	SAMPLE NUMBER	EHST-0102-107	EHST-0105-200	EHST-0109-102	EHST-0110-104	EHST-0111-105	EHST-0111-205
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						
Common Ions: ppm unless noted							
	Bicarbonate (HCO3)		237	220			150
	Calcium (Ca) (DIS)		98				
	Carbonate As CO3			<1			<1
	Chloride (Cl)		226				
	Magnesium (Mg) (DIS)		23				
	Potassium (K) (DIS)		14				
	Sodium (Na) (DIS)		490				
	Sulfate (SO4)		1149	870			683
	Total Alkalinity As CaCO3		194	180			123
Metals: ppm unless noted							
	Aluminum (Al) (DIS)		<0.05				
	Arsenic (As) (DIS)	19	20	21			20
	Arsenic +3	2.5	14	24			8.7
	Arsenic +5	13	5	<0.005			12
	Cadmium (Cd) (DIS)		0.002	<0.001			
	Copper (Cu) (DIS)		0.04				
	Iron (Fe) (DIS)	<0.1	<0.05	0.6			
	Lead (Pb) (DIS)		<0.005	<0.005			
	Manganese (Mn) (DIS)		2.6	2.7			
	Zinc (Zn) (DIS)		0.2	0.2			
Other: ppm unless noted							
	Silicon+Silica (Si+SiO2)		26				
Physical/Fld-Lab: ppm unless noted							
	Iron (Fe) (Fld)			0.6	0.2	0.05	0.01
	Iron (Fe+2) (Fld)			0.6	0.1	0.01	0.02
	Oxygen (O) (DIS) (Fld)	1	0.8	0.1	0.8	1.3	2.07
	pH		7.7				
	Depth To Water Level (ft)	33.7	33.6	29.5	30.5	30.6	31.05
	Eh (millivolts)	296	339	187	248		
	pH (Fld)	7.4	7.5	6.8	7	6.8	6.7
	SC (umhos/cm at 25 C) (Fld)	2840	2160	2680	2590	2580	2560
	SC (umhos/cm at 25 C)		2770				
	Total Suspended Solids		41				
	TDS (Measured at 180 C)		2032				
	Water Temperature (C) (Fld)	11	14.6	12.6	12.3	12.4	12.5

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-3	STW-3	STW-3	STW-3	STW-3	STW-3
Water	SAMPLE DATE	12/7/2001	12/14/2001	12/19/2001	12/27/2001	1/10/2002	1/16/2002
	SAMPLE TIME	12:15	11:10	12:45	13:00	11:15	12:05
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L011626005	L011652003	L011661007	L011677003	L020025005	L020027005
	SAMPLE NUMBER	EHST-0112-204	EHST-0112-302	EHST-0112-406	EHST-0112-502	EHST-0201-104	EHST-0201-204
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						
Common Ions: ppm unless noted							
	Bicarbonate (HCO3)	168	173	173	159	173	183
	Carbonate As CO3	<1	<1	<1	<1	<1	<1
	Sulfate (SO4)	692	744	890	879	829	841
	Total Alkalinity As CaCO3	138	142	142	130	142	150
Metals: ppm unless noted							
	Arsenic (As) (DIS)	20	20	21	19	20	20
	Arsenic +3	8.5		10		8.1	
	Arsenic +5	13		11		12	
	Cadmium (Cd) (DIS)	<0.001		<0.001		0.002	
	Iron (Fe) (DIS)	0.03	0.03	0.02	<0.02	<0.02	0.03
	Lead (Pb) (DIS)	<0.005		<0.005		<0.005	
	Manganese (Mn) (DIS)	2.3		2		1.9	
	Zinc (Zn) (DIS)	0.2		0.2		0.1	
Physical/Fld-Lab: ppm unless noted							
	Iron (Fe+2) (Fld)		<0.01				
	Oxygen (O) (DIS) (Fld)	1.3	1.3	2.1	2.1	2.4	2.1
	Depth To Water Level (ft)	31.7	31.8	32	34.2	32.5	32.7
	pH (Fld)	6.9	6.9	6.7	6.8	6.9	6.8
	SC (umhos/cm at 25 C) (Fld)	2600	2610	2520	2500	2520	2510
	Water Temperature (C) (Fld)	12.4	12.3	12.4	12.3	12.5	12.4

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-5	STW-5	STW-5	STW-5	STW-5	STW-5
Water	SAMPLE DATE	1/23/2002	2/5/2002	2/19/2002	2/22/2002	2/27/2002	4/19/2002
	SAMPLE TIME	11:20	13:40	14:30	10:35	12:35	14:00
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L020042005	L020075005	L020110008	L020118003	L020142006	L020278003
	SAMPLE NUMBER	EHST-0201-304	EHST-0202-404	EHST-0202-907	EHST-0202-102	EHST-0202-205	EHST-0204-104
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						

Common Ions: ppm unless noted

Bicarbonate (HCO3)	166	176	171	178	173	154
Carbonate As CO3	<1	<1	<1	<1	<1	<1
Sulfate (SO4)	903	941	969	1020	878	973
Total Alkalinity As CaCO3	136	144	140	146	142	126

Metals: ppm unless noted

Arsenic (As) (DIS)	20	21	20	20	20	19
Arsenic +3	7.3	7.8	7			6.8
Arsenic +5	14	13	13			11
Cadmium (Cd) (DIS)	<0.001	<0.001	<0.001			0.001
Copper (Cu) (DIS)			0.02			
Iron (Fe) (DIS)	<0.02	0.04	<0.02	0.03	<0.02	<0.02
Lead (Pb) (DIS)	<0.005	<0.005	<0.005			<0.005
Manganese (Mn) (DIS)	1.8	2.1	2			1.7
Zinc (Zn) (DIS)	0.1	0.1	0.1			0.1

Physical/Fid-Lab: ppm unless noted

Oxygen (O) (DIS) (Fid)	2.6	2.3	2.3	2.5	2.9	2.6
pH			7.4			
Depth To Water Level (ft)	32.9	33.2	33.7	33.7	34.1	34.6
pH (Fid)	6.5	6.8	7.2	7.2	6.7	7.02
SC (umhos/cm at 25 C) (Fid)	2530	2550	2510	2520	2550	2760
SC (umhos/cm at 25 C)			2570			
Water Temperature (C) (Fid)	12.4	12.4	12.4	12.6	12.3	12.7

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-5	STW-5	STW-5	STW-5	STW-5	STW-5
Water	SAMPLE DATE	5/10/2002	6/6/2002	8/8/2002	8/8/2002	9/26/2002	9/26/2002
	SAMPLE TIME	14:40	14:15	00:00	16:00	16:20	16:20
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L020364003	L020426004	L020685001	L020638008	L020829006	L020829010
	SAMPLE NUMBER	EHST-0205-102	EHST-0206-103	EHST-0208-107RR	EHST-0208-107	EHST-0209-605	EHST-0209-608
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						
Common Ions: ppm unless noted							
	Bicarbonate (HCO3)	163	159		146	149	183
	Calcium (Ca) (DIS)		93				
	Carbonate As CO3	<1	<1		<1	<1	<1
	Chloride (Cl)		168				
	Magnesium (Mg) (DIS)		22				
	Potassium (K) (DIS)		13				
	Sodium (Na) (DIS)		501				
	Sulfate (SO4)	966 J	928		1031	1052	973
	Total Alkalinity As CaCO3	134	130		120	122	150
Metals: ppm unless noted							
	Aluminum (Al) (DIS)		<0.05				
	Arsenic (As) (DIS)	19	18	10	16	16	25
	Arsenic +3	5.4	12		14	16	27
	Arsenic +5	14	7		2	<0.005	<0.005
	Cadmium (Cd) (DIS)	0.001	<0.001				
	Copper (Cu) (DIS)		0.009				
	Iron (Fe) (DIS)	0.03	0.02	<0.02	<0.02	<0.02	0.03
	Lead (Pb) (DIS)	<0.005	<0.005				
	Manganese (Mn) (DIS)	1.9	1.7				
	Zinc (Zn) (DIS)	0.2	0.1				
Other: ppm unless noted							
	Silicon+Silica (Si+SiO2)		23				
Physical/Fld-Lab: ppm unless noted							
	Oxygen (O) (DIS) (Fld)	2.7	3.4		5.9	3.9	1
	pH		7.3				
	Depth To Water Level (ft)	34.6	33.8		29.5	29.6	29.7
	pH (Fld)	5.5	6.8		6.9	6.9	6.8
	SC (umhos/cm at 25 C) (Fld)	2350	2620		2930	2560	2630
	SC (umhos/cm at 25 C)		2680				
	Total Suspended Solids		7.3				
	TDS (Measured at 180 C)		1929				
	Water Temperature (C) (Fld)	12.3	13.1		12.3	12.2	12.3

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-5	STW-5	STW-5	STW-5	STW-5
Water	SAMPLE DATE	11/13/2002	11/13/2002	6/2/2003	10/30/2003	5/13/2004
	SAMPLE TIME	11:30	11:30	00:00	00:00	13:19
	LAB	TSC-SLC	TSC-SLC	ASARCO	TSC-SLC	ASARCO
	LAB NUMBER	L020943002	L020943013	0306-230	AEH-0310-463	AEH-0405-245
	SAMPLE NUMBER	EHC-0211-216	EHC-0211-239A	AEH-0306-230	AEH-0310-463	AEH-0405-245
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RJ	RJ	RJ	RJ	RJ
	DESCRIPTION				SWL Only Req	SWL Only Req
	REMARKS		Field Duplicate			

Common Ions: ppm unless noted

Bicarbonate (HCO3)	168	171
Calcium (Ca) (DIS)	115	116
Carbonate As CO3	<1	<1
Chloride (Cl)	186	190
Magnesium (Mg) (DIS)	26	26
Potassium (K) (DIS)	16	16
Sodium (Na) (DIS)	462	467
Sulfate (SO4)	1106	1004
Total Alkalinity As CaCO3	138	140

Metals: ppm unless noted

Aluminum (Al) (DIS)	<0.05	<0.05
Arsenic (As) (DIS)	15	15
Arsenic +3	9	9.2
Arsenic +5	6	5.8
Cadmium (Cd) (DIS)	<0.001	<0.001
Copper (Cu) (DIS)	<0.004	0.005
Iron (Fe) (DIS)	<0.02	<0.02
Lead (Pb) (DIS)	<0.005	<0.005
Manganese (Mn) (DIS)	1.7	1.9
Zinc (Zn) (DIS)	0.1	0.1

Other: ppm unless noted

Silicon+Silica (Si+SiO2)	24	24
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Physical/Fld-Lab: ppm unless noted

Oxygen (O) (DIS) (Fld)	2.3				
pH	7.4	7.1			
Depth To Water Level (ft)	31.06		31.9	30.88	32.45
pH (Fld)	6.7				
SC (umhos/cm at 25 C) (Fld)	2660				
SC (umhos/cm at 25 C)	2740	2720			
Total Suspended Solids	40	50			
TDS (Measured at 180 C)	1961	1954			
Water Temperature (C) (Fld)	12.1				

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-6	STW-6	STW-6	STW-6	STW-6	STW-6
Water	SAMPLE DATE	5/10/2000	5/18/2000	5/30/2000	6/6/2000	6/6/2000	6/13/2000
	SAMPLE TIME	13:40	12:15	12:20	11:55	11:55	11:05
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L000720003	L000759006	L000825004	L000882005	L000882006	L000910003
	SAMPLE NUMBER	EHST-0005-102	EHST-0005-115	EHST-0005-123	EHST-0006-104	EHST-0006-105	EHST-0006-202
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS					Field Duplicate	

Common Ions: ppm unless noted

Bicarbonate (HCO3)	239
Calcium (Ca) (DIS)	66
Carbonate As CO3	<1
Chloride (Cl)	182
Magnesium (Mg) (DIS)	15
Potassium (K) (DIS)	12
Sodium (Na) (DIS)	453
Sulfate (SO4)	806

Metals: ppm unless noted

Arsenic (As) (DIS)	27	28	28	28	27	25
Arsenic +3	15			17 J	21 J	
Arsenic +5	14			12	12	
Cadmium (Cd) (DIS)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Iron (Fe) (DIS)	0.09	<0.05	0.06	<0.05	<0.05	0.05
Lead (Pb) (DIS)	<0.005	<0.005	<0.005	0.08 J	<0.005 J	<0.005
Manganese (Mn) (DIS)	2.6	2.7	2.8	2.9	2.9	2.9
Zinc (Zn) (DIS)	0.1	0.2	0.2	0.1	0.1	0.2

Physical/Fld-Lab: ppm unless noted

Iron (Fe) (Fld)	0.2	0.07	0.07	0.08		0.08
Iron (Fe+2) (Fld)	0.1	0.05	0.05	0.05		0.05
Oxygen (O) (DIS) (Fld)	1.5	1	1.04	0.8	0.8	1
pH	7.8					
Depth To Water Level (ft)	32.9	32.9	32.7	32.6		32.4
Eh (millivolts)	301	282	244	257	257	250
pH (Fld)	6.9	7.05	7	6.9	6.9	6.8
SC (umhos/cm at 25 C) (Fld)	2700	2560	2680	2730	2730	2770
SC (umhos/cm at 25 C)	2560					
Water Temperature (C) (Fld)	12.2	13.8	12.6	13.9	13.9	12.9

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-6	STW-6	STW-6	STW-6	STW-6	STW-6
Water	SAMPLE DATE	6/21/2000	6/29/2000	7/13/2000	7/24/2000	8/3/2000	8/16/2000
	SAMPLE TIME	12:00	11:10	11:00	14:45	10:15	11:15
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L000964005	L001003003	L001116003	L001190007	L001239004	L001333004
	SAMPLE NUMBER	EHST-0006-304	EHST-0006-402	EHST-0007-102	EHST-0007-206	EHST-0008-103	EHST-0008-203
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						

Common Ions: ppm unless noted

Bicarbonate (HCO3)	209				212	
Calcium (Ca) (DIS)	74				84	
Carbonate As CO3	<1				<1	
Chloride (Cl)	186				187	
Magnesium (Mg) (DIS)	17				19	
Potassium (K) (DIS)	12				12	
Sodium (Na) (DIS)	468				454	
Sulfate (SO4)	887				1008 J	

Metals: ppm unless noted

Arsenic (As) (DIS)	24	24	25	23	25	24
Arsenic +3	9.6	9.4	7.4 J	4.7	5.2	4.7
Arsenic +5	11	15	19	18	24 J	19
Cadmium (Cd) (DIS)	<0.001				<0.001	
Iron (Fe) (DIS)	<0.03				0.04 U	
Lead (Pb) (DIS)	<0.005				<0.005	
Manganese (Mn) (DIS)	2.9				2.8	
Zinc (Zn) (DIS)	0.1				0.1	

Physical/Fld-Lab: ppm unless noted

Iron (Fe) (Fld)	0.08	0.04	0.03	0.05		0.06
Iron (Fe+2) (Fld)	0.02	0.01	<0.01	0.01	0.03	0.04
Oxygen (O) (DIS) (Fld)	0.9	0.8	2.6	3.1	2.5	0.8
pH	7.3				7.5	
Depth To Water Level (ft)	31.9	31.6	31.5	31.6	31.7	31.7
Eh (millivolts)	269	272	287	293	328	288
pH (Fld)	6.8	6.8	6.9	7	6.9	7.1
SC (umhos/cm at 25 C) (Fld)	2500	2610	2690	2830	2950	246
SC (umhos/cm at 25 C)	2650				2840	
Water Temperature (C) (Fld)	13.7	15.3	14.4	14.9	13.9	14.3

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-6	STW-6	STW-6	STW-6	STW-6	STW-6
Water	SAMPLE DATE	8/31/2000	9/13/2000	10/3/2000	12/20/2000	5/14/2001	9/26/2001
	SAMPLE TIME	11:50	12:25	13:10	13:45	16:30	10:35
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L001441005	L001513004	L001649006	L002044008	L010699014	L011367004
	SAMPLE NUMBER	EHST-0008-304	EHST-0009-103	EHST-0010-105	EHST-0012-107	EHST-0105-201	EHST-0109-103
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						
Common Ions: ppm unless noted							
	Bicarbonate (HCO3)				256	220	207
	Calcium (Ca) (DIS)				93	94	
	Carbonate As CO3				<1		<1
	Chloride (Cl)				173	235	
	Magnesium (Mg) (DIS)				21	21	
	Potassium (K) (DIS)				14	15	
	Sodium (Na) (DIS)				563	454	
	Sulfate (SO4)				1008	1064	898
	Total Alkalinity As CaCO3				210	180	170
Metals: ppm unless noted							
	Aluminum (Al) (DIS)					<0.05	
	Arsenic (As) (DIS)	23	25	22	24	20	20
	Arsenic +3	5.3	8.9	8.7	16	19	22
	Arsenic +5	17	16	16	11	<0.005	<0.005
	Cadmium (Cd) (DIS)				0.002	0.002	<0.001
	Copper (Cu) (DIS)				0.005	0.009	
	Iron (Fe) (DIS)				0.09	<0.05	0.07
	Lead (Pb) (DIS)				<0.005	<0.005	<0.005
	Manganese (Mn) (DIS)				3.6	3.5	3.4
	Zinc (Zn) (DIS)				0.2	0.2	0.2
Other: ppm unless noted							
	Silicon+Silica (Si+SiO2)					29	
Physical/Fld-Lab: ppm unless noted							
	Iron (Fe) (FId)	0.06		0.07			0.05
	Iron (Fe+2) (FId)	0.03		0.06	0.06		0.03
	Oxygen (O) (DIS) (FId)	0.6	0.8	0.6	1.1	0.8	0.2
	pH				7.6	7.7	
	Depth To Water Level (ft)	32	32.3	32.8	33.3	33.8	29.8
	Eh (millivolts)	308	455		313	334	188
	pH (FId)	7.2	7.4	6.6	7.08	7.5	6.7
	SC (umhos/cm at 25 C) (FId)	3080	3240	2580	3250	2060	2590
	SC (umhos/cm at 25 C)				2920	2610	
	Total Suspended Solids					149	
	TDS (Measured at 180 C)				2104	1883	
	Water Temperature (C) (FId)	13.7	15	13	11	14.9	12.7

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-6	STW-6	STW-6	STW-6	STW-6	STW-6
Water	SAMPLE DATE	10/19/2001	11/2/2001	11/20/2001	12/7/2001	12/14/2001	12/19/2001
	SAMPLE TIME	13:05	11:02	00:00	12:25	11:20	13:00
	LAB	HYDRO	HYDRO	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	FIELD ONLY	FIELD ONLY	L011587007	L011626006	L011652004	L011661008
	SAMPLE NUMBER	EHST-0110-105	EHST-0111-106	EHST-0111-206	EHST-0112-205	EHST-0112-303	EHST-0112-407
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						
Common Ions: ppm unless noted							
	Bicarbonate (HCO3)			221	209	234	234
	Carbonate As CO3			<1	11	<1	<1
	Sulfate (SO4)			614	594	823	805
	Total Alkalinity As CaCO3			181	189	192	192
Metals: ppm unless noted							
	Arsenic (As) (DIS)			19	21	21	21
	Arsenic +3			10	12		14
	Arsenic +5			11	10		8
	Cadmium (Cd) (DIS)				<0.001		<0.001
	Iron (Fe) (DIS)				0.09	0.09	0.07
	Lead (Pb) (DIS)				<0.005		<0.005
	Manganese (Mn) (DIS)				3.3		3.3
	Zinc (Zn) (DIS)				0.2		0.2
Physical/Fld-Lab: ppm unless noted							
	Iron (Fe) (Fld)	0.04	0.08	<0.01			
	Iron (Fe+2) (Fld)	0.02	0.03	<0.01		<0.01	
	Oxygen (O) (DIS) (Fld)	0.5	0.5	0.5	0.3	0.3	0.3
	Depth To Water Level (ft)	30.7	30.8	31.3	31.9	32.4	32.2
	Eh (millivolts)	268					
	pH (Fld)	7.01	6.8	6.7	7	6.9	6.8
	SC (umhos/cm at 25 C) (Fld)	2570	2570	2570	2630	2630	2540
	Water Temperature (C) (Fld)	12.3	12.4	12.6	12.4	12.3	12.4

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-6	STW-6	STW-6	STW-6	STW-6	STW-6
Water	SAMPLE DATE	12/27/2001	1/10/2002	1/16/2002	1/16/2002	1/23/2002	2/5/2002
	SAMPLE TIME	13:15	12:00	12:50	12:55	11:35	13:50
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L011677004	L020025009	L020027009	L020027010	L020042006	L020075006
	SAMPLE NUMBER	EHST-0112-503	EHST-0201-108	EHST-0201-208	EHST-0201-209	EHST-0201-305	EHST-0202-405
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS				Field Duplicate		
Common Ions: ppm unless noted							
	Bicarbonate (HCO3)	240	244	240	237	229	239
	Carbonate As CO3	<1	<1	<1	<1	<1	<1
	Sulfate (SO4)	802	794	810	805	966	900
	Total Alkalinity As CaCO3	197	200	197	194	188	196
Metals: ppm unless noted							
	Arsenic (As) (DIS)	19	20	21	21	21	21
	Arsenic +3		9.8			8.9	9
	Arsenic +5		10			12	12
	Cadmium (Cd) (DIS)		0.004			0.002	<0.001
	Iron (Fe) (DIS)	0.06	0.07	0.07	0.07	0.08	0.09
	Lead (Pb) (DIS)		<0.005			<0.005	<0.005
	Manganese (Mn) (DIS)		3.3			3.3	3.5
	Zinc (Zn) (DIS)		0.2			0.2	0.2
Physical/Fld-Lab: ppm unless noted							
	Oxygen (O) (DIS) (Fld)	0.3	0.2	0.2	0.3	0.2	0.6
	Depth To Water Level (ft)	34.4	32.8	32.9		33.1	33.5
	pH (Fld)	6.9	7	6.8	6.8	6.6	6.8
	SC (umhos/cm at 25 C) (Fld)	2560	2560	2560	2560	2560	2560
	Water Temperature (C) (Fld)	12.4	12.5	12.4	12.4	12.4	12.4

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-6	STW-6	STW-6	STW-6	STW-6	STW-6
Water	SAMPLE DATE	2/19/2002	2/27/2002	4/19/2002	5/10/2002	6/6/2002	8/8/2002
	SAMPLE TIME	14:20	12:45	15:20	00:00	15:30	17:00
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	ASARCO	TSC-SLC	TSC-SLC
	LAB NUMBER	L020110007	L020142007	L020278007	205107	L020426006	L020642004
	SAMPLE NUMBER	EHST-0202-906	EHST-0202-206	EHST-0204-106	EHST-0205-107	EHST-0206-105	EHST-0208-111
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						
Common Ions: ppm unless noted							
	Bicarbonate (HCO3)	231	215	217		203	176
	Calcium (Ca) (DIS)					121	
	Carbonate As CO3	<1	<1	<1		<1	<1
	Chloride (Cl)					168	
	Magnesium (Mg) (DIS)					28	
	Potassium (K) (DIS)					17	
	Sodium (Na) (DIS)					513	
	Sulfate (SO4)	954	914	911		1043	1099
	Total Alkalinity As CaCO3	189	176	178		166	144
Metals: ppm unless noted							
	Aluminum (Al) (DIS)					<0.05	
	Arsenic (As) (DIS)	20	20	18		15	13
	Arsenic +3	8.2		7.8		12	10
	Arsenic +5	12		10		4	3
	Cadmium (Cd) (DIS)	<0.001		0.002		0.001	
	Copper (Cu) (DIS)	0.01				0.007	
	Iron (Fe) (DIS)	0.06	0.07	0.07		0.1	0.08
	Lead (Pb) (DIS)	<0.005		<0.005		<0.005	
	Manganese (Mn) (DIS)	3.4		3.3		3.8	
	Zinc (Zn) (DIS)	0.2		0.2		0.2	
Other: ppm unless noted							
	Silicon+Silica (Si+SiO2)					28	
Physical/Fld-Lab: ppm unless noted							
	Oxygen (O) (DIS) (Fld)	1.1	1.3	1.2		1.09	3.2
	pH	7.4				7.7	
	Depth To Water Level (ft)	33.9	34.4	34.9	34.8	34	29.7
	pH (Fld)	7.05	6.8	7.2		6.8	6.9
	SC (umhos/cm at 25 C) (Fld)	2610	2660	2600		2700	2860
	SC (umhos/cm at 25 C)	2620				2750	
	Total Suspended Solids					6.7	
	TDS (Measured at 180 C)					2006	
	Water Temperature (C) (Fld)	12.6	12.3	12.8		13.8	12.4

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-6	STW-6	STW-6	STW-6	STW-6
Water	SAMPLE DATE	9/26/2002	11/13/2002	6/2/2003	10/30/2003	5/13/2004
	SAMPLE TIME	15:50	11:40	00:00	00:00	13:18
	LAB	TSC-SLC	TSC-SLC	ASARCO	TSC-SLC	ASARCO
	LAB NUMBER	L020829004	L020943003	0306-231	AEH-0310-464	AEH-0405-244
	SAMPLE NUMBER	EHST-0209-603	EHC-0211-217	AEH-0306-231	AEH-0310-464	AEH-0405-244
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI
	DESCRIPTION				SWL Only Req	SWL Only Req
	REMARKS					

Common Ions: ppm unless noted

Bicarbonate (HCO3)	184	220
Calcium (Ca) (DIS)		132
Carbonate As CO3	<1	<1
Chloride (Cl)		183
Magnesium (Mg) (DIS)		29
Potassium (K) (DIS)		18
Sodium (Na) (DIS)		436
Sulfate (SO4)	1015	979
Total Alkalinity As CaCO3	151	180

Metals: ppm unless noted

Aluminum (Al) (DIS)		<0.05
Arsenic (As) (DIS)	13	14
Arsenic +3	13	8.4
Arsenic +5	<0.005	5.6
Cadmium (Cd) (DIS)		<0.001
Copper (Cu) (DIS)		<0.004
Iron (Fe) (DIS)	0.06	0.04
Lead (Pb) (DIS)		<0.005
Manganese (Mn) (DIS)		3.6
Zinc (Zn) (DIS)		0.2

Other: ppm unless noted

Silicon+Silica (Si+SiO2)	27
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Physical/Fld-Lab: ppm unless noted

Oxygen (O) (DIS) (Fld)	2.4	0.7			
pH		7.5			
Depth To Water Level (R)	29.9	31.3	32.2	31.12	32.67
pH (Fld)	6.7	6.8			
SC (umhos/cm at 25 C) (Fld)	2480	2590			
SC (umhos/cm at 25 C)		2660			
Total Suspended Solids		2.4			
TDS (Measured at 180 C)		1917			
Water Temperature (C) (Fld)	12.2	12.1			

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-7	STW-7	STW-7	STW-7	STW-7	STW-7
Water	SAMPLE DATE	8/10/2001	9/26/2001	10/19/2001	11/2/2001	11/20/2001	11/30/2001
	SAMPLE TIME	10:30	12:15	14:35	13:04	00:00	14:30
	LAB	TSC-SLC	TSC-SLC	HYDRO	HYDRO	TSC-SLC	TSC-SLC
	LAB NUMBER	L011184001	L011367009	FIELD ONLY	FIELD ONLY	L011587008	L011606003
	SAMPLE NUMBER	EHC-0108-100	EHST-0109-108	EHST-0110-106	EHST-0111-107	EHST-0111-207	EHST-0111-302
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						
Common Ions: ppm unless noted							
	Bicarbonate (HCO3)	195	214			234	88
	Calcium (Ca) (DIS)	107					
	Carbonate As CO3		<1			<1	<1
	Chloride (Cl)	193					
	Magnesium (Mg) (DIS)	27					
	Potassium (K) (DIS)	13					
	Sodium (Na) (DIS)	472					
	Sulfate (SO4)	939	963			728	1068
	Total Alkalinity As CaCO3	160	175			192	72
Metals: ppm unless noted							
	Aluminum (Al) (DIS)	<0.05					
	Arsenic (As) (DIS)	18	23			30	17
	Arsenic +3	11	19			16	
	Arsenic +5	5	4			12	
	Cadmium (Cd) (DIS)	<0.001	<0.001				
	Copper (Cu) (DIS)	0.005					
	Iron (Fe) (DIS)	<0.02	<0.02				48
	Lead (Pb) (DIS)	<0.005	<0.005				
	Manganese (Mn) (DIS)	2.2	2.3				
	Zinc (Zn) (DIS)	0.1	0.2				
Other: ppm unless noted							
	Oxidation Reduction Potential	234.9					
	Silicon+Silica (Si+SiO2)	26					
Physical/Fid-Lab: ppm unless noted							
	Iron (Fe) (Fid)		<0.01	<0.01	0.06	<0.01	51
	Iron (Fe+2) (Fid)		<0.01	<0.01	<0.01	<0.01	
	Oxygen (O) (DIS) (Fid)	3.1	0.7	2.2	0.8	0.6	0.1
	pH	7.1					
	Depth To Water Level (ft)	30.4	31	31.6	32	32.5	
	Eh (millivolts)	0.0	191	334			
	pH (Fid)	6.6	6.4	6.9	6.8	7.05	6.3
	SC (umhos/cm at 25 C) (Fid)	2350	2680	2580	2660	2650	2800
	SC (umhos/cm at 25 C)	2610					
	Total Suspended Solids	106					
	TDS (Measured at 180 C)	1864					
	Water Temperature (C) (Fid)	13.2	12.5	12.2	12.4	12.7	12.1

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-7	STW-7	STW-7	STW-7	STW-7	STW-7
Water	SAMPLE DATE	12/4/2001	12/7/2001	12/12/2001	12/14/2001	12/19/2001	12/27/2001
	SAMPLE TIME	13:00	13:20	11:23	12:10	13:45	14:30
	LAB	TSC-SLC	TSC-SLC	HYDRO	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L011614003	L011626011	FIELD ONLY	L011652009	L011661011	L011677009
	SAMPLE NUMBER	EHST-0112-102	EHST-0112-210	EHST-0112-252	EHST-0112-308	EHST-0112-410	EHST-0112-508
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						
Common Ions: ppm unless noted							
	Bicarbonate (HCO3)	157	171		220	222	242
	Carbonate As CO3	<1	<1		<1	<1	<1
	Sulfate (SO4)	901	732		793	950	836
	Total Alkalinity As CaCO3	129	140		180	182	198
Metals: ppm unless noted							
	Arsenic (As) (DIS)	21	18		19	24	24
	Arsenic +3		13			26	
	Arsenic +5		6			<0.02	
	Cadmium (Cd) (DIS)		<0.001			<0.001	
	Iron (Fe) (DIS)	28	9.1		1	2.4	0.7
	Lead (Pb) (DIS)		<0.005			<0.005	
	Manganese (Mn) (DIS)		4			3.1	
	Zinc (Zn) (DIS)		0.4			0.2	
Physical/Fld-Lab: ppm unless noted							
	Iron (Fe+2) (Fld)	20	5.6	2.3	0.7		
	Oxygen (O) (DIS) (Fld)	0.5	0.9	0.4	0.3	0.4	0.5
	Depth To Water Level (ft)	32.8	33.7	33.1	33.2	33.4	35.5
	pH (Fld)	6.5	6.7	6.6	6.7	6.7	6.7
	SC (umhos/cm at 25 C) (Fld)	2660	2700	2610	2710	2670	2630
	Water Temperature (C) (Fld)	12.2	12.2	12.4	12.2	12.4	12.4

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-7	STW-7	STW-7	STW-7	STW-7	STW-7
Water	SAMPLE DATE	1/10/2002	1/16/2002	1/23/2002	2/5/2002	2/5/2002	2/12/2002
	SAMPLE TIME	10:15	11:15	10:40	14:30	14:40	09:40
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L020025002	L020027003	L020042002	L020075010	L020075011	L020096001
	SAMPLE NUMBER	EHST-0201-101	EHST-0201-202	EHST-0201-301	EHST-0202-409	EHST-0202-410	EHST-0202-500
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS					Field Duplicate	
Common Ions: ppm unless noted							
	Bicarbonate (HCO3)	232	234	239	244	264	<1
	Carbonate As CO3	<1	<1	<1	<1	<1	<1
	Sulfate (SO4)	876	842	951	920	888	2598
	Total Alkalinity As CaCO3	190	192	196	200	216	<1
Metals: ppm unless noted							
	Arsenic (As) (DIS)	28	28	28	31	31	14
	Arsenic +3	22		17	18	17	
	Arsenic +5	5		12	13	14	
	Cadmium (Cd) (DIS)	0.004		0.001	<0.001	<0.001	
	Iron (Fe) (DIS)	0.5	0.3	0.3	0.3	0.2	508
	Lead (Pb) (DIS)	<0.005		<0.005	<0.005	<0.005	
	Manganese (Mn) (DIS)	2.9		2.8	3	3	
	Zinc (Zn) (DIS)	0.1		0.1	0.1	0.1	
Physical/Fld-Lab: ppm unless noted							
	Iron (Fe) (Fld)						470
	Oxygen (O) (DIS) (Fld)	0.3	0.5	0.3	1.2	1.05	1.04
	Depth To Water Level (ft)	33.9	34.04	34.3	34.6		34.9
	pH (Fld)	6.9	6.7	6.5	6.9	6.9	5.8
	SC (umhos/cm at 25 C) (Fld)	2650	2660	2620	2640	2660	4330
	Water Temperature (C) (Fld)	12.5	12.4	12.5	12.3	12.3	11.7

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-7	STW-7	STW-7	STW-7	STW-7	STW-7
Water	SAMPLE DATE	2/13/2002	2/14/2002	2/15/2002	2/19/2002	2/22/2002	2/27/2002
	SAMPLE TIME	15:30	15:00	00:00	15:10	10:15	11:25
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L020096010	L020101005	L020101010	L020110012	L020118001	L020142003
	SAMPLE NUMBER	EHST-0202-604	EHST-0202-704	EHST-0202-804	EHST-0202-911	EHST-0202-100	EHST-0202-202
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						

Common Ions: ppm unless noted

Bicarbonate (HCO3)	54	68	63	146	176	193
Carbonate As CO3	<1	<1	<1	<1	<1	<1
Sulfate (SO4)	1084	1197	980	996	977	1004
Total Alkalinity As CaCO3	44	56	52	120	144	158

Metals: ppm unless noted

Arsenic (As) (DIS)	16	6.7	4.5	2.8	6.3	12
Arsenic +3				1.6		
Arsenic +5				1.2		
Cadmium (Cd) (DIS)				<0.001		
Copper (Cu) (DIS)				0.009		
Iron (Fe +2)			26.4			
Iron (Fe) (DIS)	101	52	28	0.9	0.3	0.02
Lead (Pb) (DIS)				<0.005		
Manganese (Mn) (DIS)				2.9		
Zinc (Zn) (DIS)				0.3		

Physical/Fld-Lab: ppm unless noted

Iron (Fe) (Fld)	90.5	45				
Oxygen (O) (DIS) (Fld)	0.4	2.7	3.2	2.7	4	6.05
pH				7.2		
Depth To Water Level (ft)	34.8	35.3	35	35.03	35.1	36.1
pH (Fld)	6.5	6.5	6.7	7	6.6	6.8
SC (umhos/cm at 25 C) (Fld)	2760	2660	2720	2690	2700	2690
SC (umhos/cm at 25 C)				2680		
Water Temperature (C) (Fld)	12.4	12	12.1	12.6	12.7	12.2

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-7	STW-7	STW-7	STW-7	STW-7	STW-7
Water	SAMPLE DATE	4/19/2002	5/10/2002	6/6/2002	7/17/2002	7/19/2002	7/24/2002
	SAMPLE TIME	15:40	15:30	16:30	14:15	15:40	11:30
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L020278010	L020364006	L020426009	L020591002	L020591006	L020594001
	SAMPLE NUMBER	EHST-0204-109	EHST-0205-105	EHST-0206-108	EHST-0207-101	EHST-0207-200	EHST-0207-300
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						
Common Ions: ppm unless noted							
	Bicarbonate (HCO ₃)	240	232	222	176	<1	20
	Calcium (Ca) (DIS)			78			
	Carbonate As CO ₃	<1	<1	<1	<1	<1	<1
	Chloride (Cl)			210			
	Magnesium (Mg) (DIS)			18			
	Potassium (K) (DIS)			13			
	Sodium (Na) (DIS)			539			
	Sulfate (SO ₄)	950	952 J	970	912	1564	1051
	Total Alkalinity As CaCO ₃	197	190	182	144	<1	16
Metals: ppm unless noted							
	Aluminum (Al) (DIS)			<0.05			
	Arsenic (As) (DIS)	28	27	27	21	0.6	0.1
	Arsenic +3	10	6.6	18	6.1	<0.005	0.02
	Arsenic +5	18	20	9	15	0.6	0.08
	Cadmium (Cd) (DIS)	<0.001	<0.001	<0.001			<0.001
	Copper (Cu) (DIS)			0.01			
	Iron (Fe) (DIS)	0.04	0.02	0.03	<0.02	88	0.9
	Lead (Pb) (DIS)	<0.005	<0.005	<0.005			<0.005
	Manganese (Mn) (DIS)	2.7	2.6	2.7			4.4
	Zinc (Zn) (DIS)	0.2	0.2	0.2			1
Other: ppm unless noted							
	Silicon+Silica (Si+SiO ₂)			26			
Physical/Fld-Lab: ppm unless noted							
	Oxygen (O) (DIS) (Fld)	5.2	7.6	6.06	7.6	7.6	7.4
	pH			7.4			
	Depth To Water Level (ft)	36	36	35.2	32	31.4	
	pH (Fld)	7.2	7.3	7.03	7	5.6	5.7
	SC (umhos/cm at 25 C) (Fld)	2940	2720	2770	2390	2440	2140
	SC (umhos/cm at 25 C)			2790			
	Total Suspended Solids			11			
	TDS (Measured at 180 C)			2003			
	Water Temperature (C) (Fld)	13	12.8	14.2	12.9	13.1	12.8

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB
ASARCO, East Helena Plant

Sample Matrix	STATION	STW-7	STW-7	STW-7	STW-7	STW-7	STW-7
Water	SAMPLE DATE	7/25/2002	7/31/2002	8/1/2002	8/8/2002	8/9/2002	8/14/2002
	SAMPLE TIME	12:20	10:30	13:30	15:15	10:30	13:24
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L020594007	L020606001	L020606006	L020638005	L020642006	L020650001
	SAMPLE NUMBER	EHST-0207-401	EHST-0207-500	EHST-0207-600	EHST-0208-104	EHST-0208-201	EHST-0208-300
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						
Common Ions: ppm unless noted							
	Bicarbonate (HCO3)	<1	<1	<1	<1	<1	<1
	Carbonate As CO3	<1	<1	<1	<1	<1	<1
	Sulfate (SO4)	2783	1148	3581	1307	3248	1668
	Total Alkalinity As CaCO3	<1	<1	<1	<1	<1	<1
Metals: ppm unless noted							
	Arsenic (As) (DIS)	0.6	0.1	0.2	0.2	0.2	0.2
	Arsenic +3	<0.005	0.08	<0.005	<0.005	<0.005	<0.005
	Arsenic +5	0.6	0.02	0.2	0.2	0.2	0.2
	Cadmium (Cd) (DIS)	0.002					
	Iron (Fe) (DIS)	487	22	767	58	828	209
	Lead (Pb) (DIS)	<0.005					
	Manganese (Mn) (DIS)	22					
	Zinc (Zn) (DIS)	6.9					
Physical/Fld-Lab: ppm unless noted							
	Oxygen (O) (DIS) (Fld)	5.8	7.4	8.5	7.2	6.01	4.8
	Depth To Water Level (ft)		30.9	31.3	30.9		30.6
	pH (Fld)	4.7	3.8	3.9	3.7	3.7	3.4
	SC (umhos/cm at 25 C) (Fld)	4570	2700	4000	2960	4700	2780
	Water Temperature (C) (Fld)	14	14	14.8	12.1	12.7	13.2

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-7	STW-7	STW-7	STW-7	STW-7	STW-7
Water	SAMPLE DATE	8/15/2002	8/22/2002	8/28/2002	9/4/2002	9/6/2002	9/12/2002
	SAMPLE TIME	14:45	10:30	13:00	14:35	09:45	17:30
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L020650006	L020686001	L020705001	L020731001	L020749001	L020775002
	SAMPLE NUMBER	EHST-0208-400	EHST-0208-500	EHST-0208-600	EHST-0209-100	EHST-0209-200	EHST-0209-301
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						
Common Ions: ppm unless noted							
	Bicarbonate (HCO3)	<1	<1	<1	<1	<1	<1
	Carbonate As CO3	<1	<1	<1	<1	<1	<1
	Sulfate (SO4)	2850	1677	1130	1063	2402	1805
	Total Alkalinity As CaCO3	<1	<1	<1	<1	<1	<1
Metals: ppm unless noted							
	Arsenic (As) (DIS)	0.1	0.2	0.2	0.1	0.1	0.09
	Arsenic +3	<0.005	<0.005	0.04	0.04	<0.005	0.006
	Arsenic +5	0.1	0.2	0.1	0.1	0.1	0.08
	Iron (Fe) (DIS)	810	99	20	8.6	<442	63
Physical/Fid-Lab: ppm unless noted							
	Oxygen (O) (DIS) (Fid)	4.7	4.03	5.2	5.1	5.5	4.2
	Depth To Water Level (ft)		30.8	30.7	30.8	31.1	30.8
	pH (Fid)	3.4	2.9	3.04	3.6	3.1	2.8
	SC (umhos/cm at 25 C) (Fid)	4430	2940	2380	1893	3660	3150
	TDS (Measured at 180 C)				2035		
	Water Temperature (C) (Fid)	13.5	14.2	12.7	14	13.4	12.5

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-7	STW-7	STW-7	STW-7	STW-7	STW-7
Water	SAMPLE DATE	9/19/2002	9/20/2002	9/26/2002	10/4/2002	10/5/2002	10/17/2002
	SAMPLE TIME	11:25	10:15	17:40	14:50	10:30	11:30
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L020785001	L020785006	L020829012	L020845005	L020845006	L020869005
	SAMPLE NUMBER	EHST-0209-400	EHST-0209-500	EHST-0209-610	EHST-0210-103	EHST-0210-200	EHST-0210-304
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						
Common Ions: ppm unless noted							
	Bicarbonate (HCO3)	<1	<1	<1	<1	<1	<1
	Carbonate As CO3	<1	<1	<1	<1	<1	<1
	Sulfate (SO4)	1198	3234	1529	1157	2715	1314
	Total Alkalinity As CaCO3	<1	<1	<1	<1	<1	<1
Metals: ppm unless noted							
	Arsenic (As) (DIS)	0.03	0.06	0.1	0.02	0.05	0.05
	Arsenic +3	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
	Arsenic +5	0.03	0.05	0.09	0.02	0.05	0.04
	Iron (Fe) (DIS)	21	765	114	21	951	49
Physical/Fld-Lab: ppm unless noted							
	Oxygen (O) (DIS) (Fld)	5.8	5.3	2.8	4.9	3.6	5.7
	Depth To Water Level (ft)	31.5	31	31	31.3	31.2	31.5
	pH (Fld)	2.9	2.9	4.3	2.8	2.6	3
	SC (umhos/cm at 25 C) (Fld)	3040	5080	3370	1702	5230	3410
	Water Temperature (C) (Fld)	12.5	12.5	12.3	12.4	12.6	12.2

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-7	STW-7	STW-7	STW-7	STW-7	STW-7
Water	SAMPLE DATE	10/23/2002	10/31/2002	11/13/2002	12/17/2002	12/17/2002	1/14/2003
	SAMPLE TIME	14:00	15:15	12:20	12:15	12:15	10:50
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L020888005	L020915005	L020943007	L021034003	L021034-003	L030016-002
	SAMPLE NUMBER	EHST-0210-404	EHST-0210-504	EHST-0211-218	EHST-0212-102	EHST-0212-102	EHST-0212-101
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						

Common Ions: ppm unless noted

Bicarbonate (HCO3)	<1	<1	<1	<2	<2	<2
Calcium (Ca) (DIS)			182			
Carbonate As CO3	<1	<1	<1	<2	<2	<2
Chloride (Cl)			188			
Magnesium (Mg) (DIS)			56			
Potassium (K) (DIS)			12			
Sodium (Na) (DIS)			470			
Sulfate (SO4)	2295	2382	2185	1237	1237	942
Total Alkalinity As CaCO3	<1	<1	<1	<2	<2	<2

Metals: ppm unless noted

Aluminum (Al) (DIS)			12			
Arsenic (As) (DIS)	1.1	1.7	0.7	0.05	0.045	0.066
Arsenic +3	<0.005	0.008	<0.005	0.02	0.021	<0.005
Arsenic +5	1.1	1.6	0.7	0.03	0.027	0.062
Cadmium (Cd) (DIS)			0.006			
Copper (Cu) (DIS)			0.3			
Iron (Fe) (DIS)	255	419	199	31	31	<45
Lead (Pb) (DIS)			<0.005			
Manganese (Mn) (DIS)			45			
Zinc (Zn) (DIS)			14			

Other: ppm unless noted

Silicon+Silica (Si+SiO2)			85			
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Physical/Fld-Lab: ppm unless noted

Oxygen (O) (DIS) (Fld)	2.3	1	2.6	3.5	3.49	0.77
pH			2.7			
Depth To Water Level (ft)	31.7	32.02	32.4	33.4	33.38	34.18
pH (Fld)	4350	2.5	2.2	2.8	2.78	3.19
SC (umhos/cm at 25 C) (Fld)	2.5	5380	4160	2610	2619	2490
SC (umhos/cm at 25 C)			4070			
Total Suspended Solids			22			
TDS (Measured at 180 C)			3324			
Water Temperature (C) (Fld)	12	11.2	11.8	11.7	11.7	12.1

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-7	STW-7	STW-7	STW-8	STW-8
Water	SAMPLE DATE	6/2/2003	10/30/2003	5/20/2004	8/10/2001	9/26/2001
	SAMPLE TIME	11:00	08:30	11:15	13:00	12:00
	LAB	TSC-SLC	TSC-SLC	ELI	TSC-SLC	TSC-SLC
	LAB NUMBER	L030245005	L030605014	H04050133-007	L011184002	L011367008
	SAMPLE NUMBER	AEH-0306-167	AEH-0310-437	AEH-0405-130	EHC-0108-101	EHST-0109-107
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI
	DESCRIPTION					
	REMARKS					

Common Ions: ppm unless noted

Bicarbonate (HCO3)	<2	24	271	228
Calcium (Ca) (DIS)	31	66	97	
Carbonate As CO3	<2	<2		<1
Chloride (Cl)	167	139	215	
Magnesium (Mg) (DIS)	11	20	23	
Potassium (K) (DIS)	9.4	13	15	
Sodium (Na) (DIS)	432	385	552	
Sulfate (SO4)	894	889	988	991
Total Alkalinity As CaCO3	<2	20	222	187

Common Ions (mg/L): ppm unless noted

Bicarbonate (HCO3)	110
Calcium (Ca) (DIS)	63
Chloride (Cl)	120
Magnesium (Mg) (DIS)	17
Potassium (K) (DIS)	13
Sodium (Na) (DIS)	359
Sulfate (SO4)	870
Total Alkalinity As CaCO3	94

Metals: ppm unless noted

Aluminum (Al) (DIS)		<0.05	
Arsenic (As) (DIS)	0.05	0.1	23
Arsenic +3	0.01	0.06	25
Arsenic +5	0.05	0.08	<0.005
Cadmium (Cd) (DIS)	<0.001	<0.001	<0.001
Copper (Cu) (DIS)	0.03 J	0.01	<0.004
Iron (Fe) (DIS)	19	4.2	0.06
Lead (Pb) (DIS)	<0.005	<0.005	<0.005
Manganese (Mn) (DIS)	4	4.6	3.6
Zinc (Zn) (DIS)	4.7	1.5	0.2

Metals (mg/L): ppm unless noted

Arsenic (As) (DIS)	0.852
Arsenic +3	0.16 J
Arsenic +5	0.032 UJ
Cadmium (Cd) (DIS)	<0.001
Copper (Cu) (DIS)	0.004
Iron (Fe) (DIS)	4.86
Lead (Pb) (DIS)	<0.005
Manganese (Mn) (DIS)	2.52
Zinc (Zn) (DIS)	0.65

Other: ppm unless noted

Oxidation Reduction Potential	153.3
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TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-7	STW-7	STW-7	STW-8	STW-8
Water	SAMPLE DATE	6/2/2003	10/30/2003	5/20/2004	8/10/2001	9/26/2001
	SAMPLE TIME	11:00	08:30	11:15	13:00	12:00
	LAB	TSC-SLC	TSC-SLC	ASARCO	TSC-SLC	TSC-SLC
	LAB NUMBER	L030245005	L030605014	H04050133-007	L011184002	L011367008
	SAMPLE NUMBER	AEH-0306-167	AEH-0310-437	AEH-0405-130	EHC-0108-101	EHST-0109-107
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RJ	RJ	RJ	RJ	RJ
	DESCRIPTION					
	REMARKS					

Other: ppm unless noted

Silicon+Silica (Si+SiO2)				28	
Physical/Fid-Lab: ppm unless noted					
Iron (Fe) (Fid)					0.3
Iron (Fe+2) (Fid)					0.2
Oxygen (O) (DIS) (Fid)	0.08	2.29		1.4	0.1
Oxygen (O) (DIS) (Fid) (DIS)			0.24		
pH	3.8	6.8	6.8	7.1	
Depth To Water Level (ft)	33.3	32.28	33.83	30.4	31
Eh (millivolts)				0.0	155
pH (Fid)	4.8	5.19	5.67	6.9	6.5
SC (umhos/cm at 25 C) (Fid)	2340	2310	2170	2640	2780
SC (umhos/cm at 25 C)	2450	2330	2150	2810	
Total Suspended Solids	40	17 J	15	93	
TDS (Measured at 180 C)	1628	1631	1460	2031	
Salinity (G/KG) (Fid)	1.1	1	1		
Turbidity (NTU) (Fid)	49	11	10		
Water Temperature (C) (Fid)	12.4	11.6	13.1	14	12.4

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-8	STW-8	STW-8	STW-8	STW-8	STW-8
Water	SAMPLE DATE	10/19/2001	11/2/2001	11/20/2001	11/30/2001	12/4/2001	12/7/2001
	SAMPLE TIME	15:00	12:47	00:00	14:05	13:30	13:05
	LAB	HYDRO	HYDRO	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	FIELD ONLY	FIELD ONLY	L011587005	L011606004	L011614004	L011626010
	SAMPLE NUMBER	EHST-0110-107	EHST-0111-108	EHST-0111-204	EHST-0111-303	EHST-0112-103	EHST-0112-209
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						
Common Ions: ppm unless noted							
	Bicarbonate (HCO3)			211	232	226	212
	Carbonate As CO3			<1	<1	<1	<1
	Sulfate (SO4)			696	819	979	717
	Total Alkalinity As CaCO3			173	190	185	174
Metals: ppm unless noted							
	Arsenic (As) (DIS)			27	28	28	29
	Arsenic +3			13			15
	Arsenic +5			15			15
	Cadmium (Cd) (DIS)						<0.001
	Iron (Fe) (DIS)				0.05	0.03	<0.02
	Lead (Pb) (DIS)						<0.005
	Manganese (Mn) (DIS)						2.4
	Zinc (Zn) (DIS)						0.2
Physical/Fid-Lab: ppm unless noted							
	Iron (Fe) (Fid)	<0.01	0.1	0.05	1.2		
	Iron (Fe+2) (Fid)	<0.01	0.05	0.01		<0.01	<0.01
	Oxygen (O) (DIS) (Fid)	2.8	2.9	2.8	1.2	1	3.4
	Depth To Water Level (ft)	31.7	31.9	32.4		32.8	33
	Eh (millivolts)	287					
	pH (Fid)	7.05	6.9	7.05	6.9	6.9	7
	SC (umhos/cm at 25 C) (Fid)	2700	2700	2670	2780	2780	2810
	Water Temperature (C) (Fid)	12.2	12.4	12.6	12.4	12.3	12.3

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-8	STW-8	STW-8	STW-8	STW-8	STW-8
Water	SAMPLE DATE	12/12/2001	12/14/2001	12/19/2001	12/27/2001	1/10/2002	1/16/2002
	SAMPLE TIME	11:38	12:00	13:30	14:15	10:30	11:00
	LAB	HYDRO	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	FIELD ONLY	L011652008	L011661010	L011677008	L020025003	L020027002
	SAMPLE NUMBER	EHST-0112-253	EHST-0112-307	EHST-0112-409	EHST-0112-507	EHST-0201-102	EHST-0201-201
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						

Common Ions: ppm unless noted

Bicarbonate (HCO3)	195	305	199	244	210
Carbonate As CO3	<1	<1	<1	<1	<1
Sulfate (SO4)	815	944	885	877	842
Total Alkalinity As CaCO3	160	250	163	200	172

Metals: ppm unless noted

Arsenic (As) (DIS)	28	27	24	30	28
Arsenic +3		17		14	
Arsenic +5		10		13	
Cadmium (Cd) (DIS)		<0.001		0.003	
Iron (Fe) (DIS)	0.04	<0.02	<0.02	<0.02	<0.02
Lead (Pb) (DIS)		<0.005		<0.005	
Manganese (Mn) (DIS)		2.6		2.1	
Zinc (Zn) (DIS)		0.3		0.2	

Physical/Fld-Lab: ppm unless noted

Iron (Fe+2) (Fld)	<0.01	<0.01			
Oxygen (O) (DIS) (Fld)	2.9	2.3	3.05	3.2	3.04
Depth To Water Level (R)	33.1	33.1	33.3	35.5	33.9
pH (Fld)	6.6	6.8	6.7	6.7	6.9
SC (umhos/cm at 25 C) (Fld)	2620	2690	2620	2610	2660
Water Temperature (C) (Fld)	12.4	12.2	12.4	12.3	12.4

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-8	STW-8	STW-8	STW-8	STW-8	STW-8
Water	SAMPLE DATE	1/23/2002	2/5/2002	2/12/2002	2/13/2002	2/14/2002	2/15/2002
	SAMPLE TIME	10:50	14:50	09:50	15:20	14:50	00:00
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L020042003	L020075012	L020096002	L020096009	L020101004	L020101009
	SAMPLE NUMBER	EHST-0201-302	EHST-0202-411	EHST-0202-501	EHST-0202-603	EHST-0202-703	EHST-0202-803
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						

Common Ions: ppm unless noted

Bicarbonate (HCO3)	210	205	205	214	207	185
Carbonate As CO3	<1	<1	<1	<1	<1	<1
Sulfate (SO4)	865	903	845	921	1183	1167
Total Alkalinity As CaCO3	172	168	168	175	170	152

Metals: ppm unless noted

Arsenic (As) (DIS)	28	30	28	27	27	27
Arsenic +3	13	11				
Arsenic +5	16	19				
Cadmium (Cd) (DIS)	0.001	<0.001				
Iron (Fe +2)					<0.01	<0.01
Iron (Fe) (DIS)	<0.02	<0.02	0.07	<0.02	0.02	<0.02
Lead (Pb) (DIS)	<0.005	<0.005				
Manganese (Mn) (DIS)	2.2	2.1				
Zinc (Zn) (DIS)	0.2	0.2				

Physical/Fld-Lab: ppm unless noted

Iron (Fe) (Fld)			<0.01	<0.01		
Oxygen (O) (DIS) (Fld)	3.5	5.3	4.6	3.2	4.7	4.3
Depth To Water Level (ft)	34.2	34.6	34.9	34.8	35.3	35.1
pH (Fld)	6.6	7.2	7	7.1	7	6.9
SC (umhos/cm at 25 C) (Fld)	2630	2570	2670	2600	3120	3180
Water Temperature (C) (Fld)	12.4	12.3	11.9	12.6	12.3	12.2

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-8	STW-8	STW-8	STW-8	STW-8	STW-8
Water	SAMPLE DATE	2/19/2002	2/19/2002	2/22/2002	2/27/2002	4/19/2002	5/10/2002
	SAMPLE TIME	14:50	15:00	10:25	11:15	15:30	15:15
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L020110010	L020110011	L020118002	L020142002	L020278009	L020364005
	SAMPLE NUMBER	EHST-0202-909	EHST-0202-910	EHST-0202-101	EHST-0202-201	EHST-0204-108	EHST-0205-104
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS		Field Duplicate				

Common Ions: ppm unless noted

Bicarbonate (HCO3)	192	178	193	193	209	210
Carbonate As CO3	<1	<1	<1	<1	<1	<1
Sulfate (SO4)	997	1026	968	918	1004	914 J
Total Alkalinity As CaCO3	157	146	158	158	171	172

Metals: ppm unless noted

Arsenic (As) (DIS)	26	26	25	23	23	23
Arsenic +3	9.7	9.8			8.4	6.5
Arsenic +5	16	15			14	16
Cadmium (Cd) (DIS)	<0.001	<0.001			<0.001	<0.001
Copper (Cu) (DIS)	0.02	0.03				
Iron (Fe) (DIS)	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Lead (Pb) (DIS)	<0.005	<0.005			<0.005	<0.005
Manganese (Mn) (DIS)	2.9	2.9			2.3	2.2
Zinc (Zn) (DIS)	0.3	0.3			0.2	0.2

Physical/Fld-Lab: ppm unless noted

Oxygen (O) (DIS) (Fld)	5	5	5.4	6.6	5.05	7.1
pH	7.8	7.5				
Depth To Water Level (ft)	35		35.06	36.7	35.9	35.9
pH (Fld)	7.05	7.05	6.9	6.9	7.4	7.3
SC (umhos/cm at 25 C) (Fld)	2740	2750	2570	2600	2920	2470
SC (umhos/cm at 25 C)	2770	2770				
Water Temperature (C) (Fld)	12.4	12.4	12.6	11.9	12.9	12.9

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-8	STW-8	STW-8	STW-8	STW-8	STW-8
Water	SAMPLE DATE	6/6/2002	7/17/2002	7/19/2002	7/24/2002	7/25/2002	7/31/2002
	SAMPLE TIME	16:10	14:00	15:50	12:00	12:00	11:00
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L020426008	L020591001	L020591007	L020594002	L020594006	L020606002
	SAMPLE NUMBER	EHST-0206-107	EHST-0207-100	EHST-0207-201	EHST-0207-301	EHST-0207-400	EHST-0207-501
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						

Common Ions: ppm unless noted

Bicarbonate (HCO3)	205	185	173	162	160	148
Calcium (Ca) (DIS)	88					
Carbonate As CO3	<1	<1	<1	<1	<1	<1
Chloride (Cl)	209					
Magnesium (Mg) (DIS)	21					
Potassium (K) (DIS)	14					
Sodium (Na) (DIS)	555					
Sulfate (SO4)	1129	1112	1336	1048	964	1149
Total Alkalinity As CaCO3	168	152	142	133	131	121

Metals: ppm unless noted

Aluminum (Al) (DIS)	<0.05					
Arsenic (As) (DIS)	23	18	19	18	17	14
Arsenic +3	15	11	14	13	6.2	4.7
Arsenic +5	7	10	5	5	12	11
Cadmium (Cd) (DIS)	<0.001			<0.001	<0.001	
Copper (Cu) (DIS)	0.01					
Iron (Fe) (DIS)	<0.02	<0.02	<0.02	<0.02	0.03	0.8
Lead (Pb) (DIS)	<0.005			<0.005	<0.005	
Manganese (Mn) (DIS)	2.4			3.3	3.2	
Zinc (Zn) (DIS)	0.2			0.3	0.3	

Other: ppm unless noted

Silicon+Silica (Si+SiO2)	26					
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Physical/Fld-Lab: ppm unless noted

Oxygen (O) (DIS) (Fld)	4.3	4.2	4.7	5.7	4.3	5.2
pH	7.4					
Depth To Water Level (ft)	35.1	32.9	31.6			30.9
pH (Fld)	6.9	6.9	6.7	6.9	6.9	6.3
SC (umhos/cm at 25 C) (Fld)	2730	2610	2730	2240	2840	2910
SC (umhos/cm at 25 C)	2800					
Total Suspended Solids	75					
TDS (Measured at 180 C)	1998					
Water Temperature (C) (Fld)	14.3	13.3	13.7	13.2	13	13.4

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-8	STW-8	STW-8	STW-8	STW-8	STW-8
Water	SAMPLE DATE	8/1/2002	8/8/2002	8/9/2002	8/14/2002	8/15/2002	8/22/2002
	SAMPLE TIME	14:00	15:00	10:15	13:40	15:00	10:45
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L020606007	L020638004	L020642005	L020650002	L020650007	L020686002
	SAMPLE NUMBER	EHST-0207-601	EHST-0208-103	EHST-0208-200	EHST-0208-301	EHST-0208-401	EHST-0208-501
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						
Common Ions: ppm unless noted							
	Bicarbonate (HCO3)	142	124	117	95	93	79
	Carbonate As CO3	<1	<1	<1	<1	<1	<1
	Sulfate (SO4)	1039	1072	1207	1152	1119	1208
	Total Alkalinity As CaCO3	116	102	96	78	76	65
Metals: ppm unless noted							
	Arsenic (As) (DIS)	14	11	11	8.3	9	6.7
	Arsenic +3	12	5.3	2	1.2	1.4	0.4
	Arsenic +5	4	5.7	9	6.9	7.8	6.3
	Iron (Fe) (DIS)	1.6	2.4	6	12	11	13
Physical/Fld-Lab: ppm unless noted							
	Oxygen (O) (DIS) (Fld)	5.8	5	4.04	2.2	3.2	3.6
	Depth To Water Level (ft)	30.8	30.8		30.6		30.8
	pH (Fld)	6.5	6.6	6.4	5.8	6	5.7
	SC (umhos/cm at 25 C) (Fld)	2080	2910	2820	2410	2350	2410
	Water Temperature (C) (Fld)	13.6	12.4	12.6	13.4	13.1	14.4

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-8	STW-8	STW-8	STW-8	STW-8	STW-8
Water	SAMPLE DATE	8/28/2002	9/4/2002	9/6/2002	9/12/2002	9/19/2002	9/20/2002
	SAMPLE TIME	13:15	14:45	10:00	17:50	11:40	10:30
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L020705002	L020731002	L020749002	L020775003	L020785002	L020785007
	SAMPLE NUMBER	EHST-0208-601	EHST-0209-101	EHST-0209-201	EHST-0209-302	EHST-0209-401	EHST-0209-501
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						

Common Ions: ppm unless noted

Bicarbonate (HCO3)	115	124	109	126	144	142
Carbonate As CO3	<1	<1	<1	<1	<1	<1
Sulfate (SO4)	1063	975	992	1040	1220	1089
Total Alkalinity As CaCO3	94	102	109	103	118	116

Metals: ppm unless noted

Arsenic (As) (DIS)	11	11	12	11	12	12
Arsenic +3	5.8	8.3	4.2	12	13	9.6
Arsenic +5	5.2	3	7.8	<0.005	<0.005	2.4
Iron (Fe) (DIS)	1.7	<0.02	0.9	2	0.8	0.7

Physical/Fld-Lab: ppm unless noted

Oxygen (O) (DIS) (Fld)	5	4.2	4.09	4.3	3.3	3.8
Depth To Water Level (ft)	30.7	30.8	31.1	30.7	33.5	30.9
pH (Fld)	6.2	6.6	6.3	6.5	6.3	6.4
SC (umhos/cm at 25 C) (Fld)	2130	1880	2240	2600	2720	2770
TDS (Measured at 180 C)		2018				
Water Temperature (C) (Fld)	13	13	12.6	12.7	12.8	12.4

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-8	STW-8	STW-8	STW-8	STW-8	STW-8
Water	SAMPLE DATE	9/26/2002	10/4/2002	10/5/2002	10/17/2002	10/23/2002	10/31/2002
	SAMPLE TIME	17:20	14:40	10:45	11:15	13:45	14:55
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L020829011	L020845004	L020845007	L020869004	L020888004	L020915004
	SAMPLE NUMBER	EHST-0209-609	EHST-0210-102	EHST-0210-201	EHST-0210-303	EHST-0210-403	EHST-0210-503
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						

Common Ions: ppm unless noted

Bicarbonate (HCO3)	132	151	151	156	159	161
Carbonate As CO3	<1	<1	<1	<1	<1	<1
Sulfate (SO4)	1011	1050	1014	906	1092	983
Total Alkalinity As CaCO3	108	124	124	128	130	132

Metals: ppm unless noted

Arsenic (As) (DIS)	11	12	12	13	13	14
Arsenic +3	12	8.9	6	13	14	16
Arsenic +5	<0.005	3.1	7	<0.005	<0.005	<0.005
Iron (Fe) (DIS)	1.1	0.4	0.2	0.03	0.09	<0.02

Physical/Fid-Lab: ppm unless noted

Oxygen (O) (DIS) (Fid)	4.3	3.8	3.5	4.9	5.05	5.3
Depth To Water Level (ft)	31	31.3	31.2	31.5	31.7	32.01
pH (Fid)	6.8	6.8	6.2	6.9	6.8	7.2
SC (umhos/cm at 25 C) (Fid)	2640	1551	2630	2750	2780	3090
Water Temperature (C) (Fid)	12.3	12.4	12.1	12.2	11.9	11.1

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-8	STW-8	STW-8	STW-8	STW-8	STW-8
Water	SAMPLE DATE	11/13/2002	12/17/2002	1/14/2003	6/2/2003	10/30/2003	5/20/2004
	SAMPLE TIME	00:00	12:30	11:10	10:30	09:20	11:00
	LAB	ASARCO	ASARCO	TSC-SLC	TSC-SLC	TSC-SLC	ELI
	LAB NUMBER	0211-219	EHST-0212-103	L030016-003	L030245004	L030605016	H04050133-006
	SAMPLE NUMBER	EH-0211-219	EHST-0212-103	EHST-0212-102	AEH-0306-166	AEH-0310-439	AEH-0405-129
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						

Common Ions: ppm unless noted

Bicarbonate (HCO3)	186	237	210
Calcium (Ca) (DIS)		77	89
Carbonate As CO3	<2	<2	<2
Chloride (Cl)		155	136
Magnesium (Mg) (DIS)		20	22
Potassium (K) (DIS)		14	12
Sodium (Na) (DIS)		430	404
Sulfate (SO4)	850	980	823
Total Alkalinity As CaCO3	186	194	172

Common Ions (mg/L): ppm unless noted

Bicarbonate (HCO3)	210
Calcium (Ca) (DIS)	83
Chloride (Cl)	120
Magnesium (Mg) (DIS)	19
Potassium (K) (DIS)	14
Sodium (Na) (DIS)	361
Sulfate (SO4)	750
Total Alkalinity As CaCO3	180

Metals: ppm unless noted

Arsenic (As) (DIS)	17	17	14
Arsenic +3	17	20	3.5 J
Arsenic +5	1	<0.005	10
Cadmium (Cd) (DIS)		<0.001	<0.001
Copper (Cu) (DIS)		0.007 J	0.007
Iron (Fe) (DIS)	0.029	0.04	0.09
Lead (Pb) (DIS)		<0.005	<0.005
Manganese (Mn) (DIS)		1.3	0.9
Zinc (Zn) (DIS)		0.8	0.5

Metals (mg/L): ppm unless noted

Arsenic (As) (DIS)	10.11
Arsenic +3	0.46 J
Arsenic +5	10 J
Cadmium (Cd) (DIS)	<0.001
Copper (Cu) (DIS)	0.005
Iron (Fe) (DIS)	0.03
Lead (Pb) (DIS)	<0.005
Manganese (Mn) (DIS)	1.03
Zinc (Zn) (DIS)	0.62

Physical/Fid-Lab: ppm unless noted

Oxygen (O) (DIS) (Fid)	3.45	0.2	0.11
Oxygen (O) (DIS) (Fid) (DIS)			0.25

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-8	STW-8	STW-8	STW-8	STW-8	STW-8
Water	SAMPLE DATE	11/13/2002	12/17/2002	1/14/2003	6/2/2003	10/30/2003	5/20/2004
	SAMPLE TIME	09:00	12:30	11:10	10:30	09:20	11:00
	LAB	ASARCO	ASARCO	ASARCO	TSC-SLC	TSC-SLC	ELI
	LAB NUMBER	0211-219	EHST-0212-103	L030016-003	L030245004	L030605016	H04050133-006
	SAMPLE NUMBER	EHC-0211-219	EHST-0212-103	EHST-0212-102	AEH-0306-166	AEH-0310-439	AEH-0405-129
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						

Physical/Fld-Lab: ppm unless noted

	STW-8	STW-8	STW-8	STW-8	STW-8	STW-8
pH				7.4	7.6	7.2
Depth To Water Level (R)	32.4	31.06	31.84	31	29.95	31.47
pH (Fld)			6.47	6.4	6.24	6.16
SC (umhos/cm at 25 C) (Fld)			2450	2460	2420	2220
SC (umhos/cm at 25 C)				2550	2440	2210
Total Suspended Solids				2.6	6.6 J	<10
TDS (Measured at 180 C)				1811	1724	1510
Salinity (G/KG) (Fld)				1.1	1.1	1
Turbidity (NTU) (Fld)				1	21	10
Water Temperature (C) (Fld)			11.3	12	11.6	12.7

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-9	STW-9	STW-9	STW-9	STW-9	STW-9
Water	SAMPLE DATE	8/10/2001	9/26/2001	10/19/2001	11/2/2001	11/20/2001	11/30/2001
	SAMPLE TIME	00:00	11:35	13:50	11:54	00:00	11:30
	LAB	TSC-SLC	TSC-SLC	HYDRO	HYDRO	TSC-SLC	TSC-SLC
	LAB NUMBER	L011184003	L011367007	FIELD ONLY	FIELD ONLY	L011587012	L011606005
	SAMPLE NUMBER	EHC-0108-102	EHST-0109-106	EHST-0110-108	EHST-0111-109	EHST-0111-211	EHST-0111-304
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						
Common Ions: ppm unless noted							
	Bicarbonate (HCO3)	250	211			203	201
	Calcium (Ca) (DIS)	96					
	Carbonate As CO3		<1			<1	<1
	Chloride (Cl)	196					
	Magnesium (Mg) (DIS)	21					
	Potassium (K) (DIS)	16					
	Sodium (Na) (DIS)	503					
	Sulfate (SO4)	888	910			761	762
	Total Alkalinity As CaCO3	205	173			166	165
Metals: ppm unless noted							
	Aluminum (Al) (DIS)	<0.05					
	Arsenic (As) (DIS)	20	20			22	22
	Arsenic +3	16	18			8.8	
	Arsenic +5	3	3			14	
	Cadmium (Cd) (DIS)	<0.001	<0.001				
	Copper (Cu) (DIS)	<0.004					
	Iron (Fe) (DIS)	<0.02	<0.02				<0.02
	Lead (Pb) (DIS)	<0.005	<0.005				
	Manganese (Mn) (DIS)	3.5	3.4				
	Zinc (Zn) (DIS)	0.2	0.2				
Other: ppm unless noted							
	Oxidation Reduction Potential	191					
	Silicon+Silica (Si+SiO2)	30					
Physical/Fld-Lab: ppm unless noted							
	Iron (Fe) (Fld)		0.01	<0.01	0.01		0.02
	Iron (Fe+2) (Fld)		<0.01	<0.01	<0.01		
	Oxygen (O) (DIS) (Fld)	1.4	0.1	2.5	2.3		1.07
	pH	7.2					
	Depth To Water Level (ft)	29.1	29.7	30.3	30.7		
	Eh (millivolts)	0.0	188	322			
	pH (Fld)	7	6.5	7.02	6.9		6.9
	SC (umhos/cm at 25 C) (Fld)	2410	2600	2580	2600		2620
	SC (umhos/cm at 25 C)	2570					
	Total Suspended Solids	23					
	TDS (Measured at 180 C)	1849					
	Water Temperature (C) (Fld)	14.4	12.6	12.3	12.4		12.4

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-9	STW-9	STW-9	STW-9	STW-9	STW-9
Water	SAMPLE DATE	12/4/2001	12/7/2001	12/12/2001	12/14/2001	12/19/2001	12/27/2001
	SAMPLE TIME	14:45	12:45	12:15	11:40	12:20	13:45
	LAB	TSC-SLC	TSC-SLC	HYDRO	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L011614005	L011626008	FIELD ONLY	L011652006	L011661005	L011677006
	SAMPLE NUMBER	EHST-0112-104	EHST-0112-207	EHST-0112-254	EHST-0112-305	EHST-0112-404	EHST-0112-505
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						
Common Ions: ppm unless noted							
	Bicarbonate (HCO3)	220	224		207	211	221
	Carbonate As CO3	<1	<1		<1	<1	<1
	Sulfate (SO4)	755	616		806	842	877
	Total Alkalinity As CaCO3	180	184		170	173	181
Metals: ppm unless noted							
	Arsenic (As) (DIS)	22	21		22	23	21
	Arsenic +3		9.3			10	
	Arsenic +5		14			13	
	Cadmium (Cd) (DIS)		<0.001			<0.001	
	Iron (Fe) (DIS)	<0.02	0.03		0.04	<0.02	<0.02
	Lead (Pb) (DIS)		<0.005			<0.005	
	Manganese (Mn) (DIS)		3			3	
	Zinc (Zn) (DIS)		0.2			0.2	
Physical/Fld-Lab: ppm unless noted							
	Iron (Fe+2) (Fld)	<0.3	<0.01	0.05	<0.01		
	Oxygen (O) (DIS) (Fld)	1.2	1.9	2.6	1.9	2.4	2.5
	Depth To Water Level (ft)	31.6	31.8	31.9	31.9	32.1	34.3
	pH (Fld)	6.8	7.02	6.8	7	6.9	6.9
	SC (umhos/cm at 25 C) (Fld)	2570	2650	2570	2650	2580	2560
	Water Temperature (C) (Fld)	12.3	12.2	12.2	12.2	12.4	12.3

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-9	STW-9	STW-9	STW-9	STW-9	STW-9
Water	SAMPLE DATE	1/10/2002	1/16/2002	1/23/2002	2/5/2002	2/12/2002	2/13/2002
	SAMPLE TIME	11:30	12:15	11:55	14:10	10:20	14:55
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L020025007	L020027006	L020042008	L020075008	L020096004	L020096007
	SAMPLE NUMBER	EHST-0201-106	EHST-0201-205	EHST-0201-307	EHST-0202-407	EHST-0202-503	EHST-0202-601
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						

Common Ions: ppm unless noted

Bicarbonate (HCO3)	227	237	217	233	207	209
Carbonate As CO3	<1	<1	<1	<1	<1	<1
Sulfate (SO4)	870	877	988	933	919	908
Total Alkalinity As CaCO3	186	194	178	191	170	171

Metals: ppm unless noted

Arsenic (As) (DIS)	21	22	22	22	20	20
Arsenic +3	8.6		5.7	6.9		
Arsenic +5	12		18	16		
Cadmium (Cd) (DIS)	0.004		0.001	<0.001		
Iron (Fe) (DIS)	<0.02	<0.02	<0.02	<0.02	0.02	<0.02
Lead (Pb) (DIS)	<0.005		<0.005	<0.005		
Manganese (Mn) (DIS)	2.9		2.9	2.9		
Zinc (Zn) (DIS)	0.2		0.2	0.1		

Physical/Fld-Lab: ppm unless noted

Iron (Fe) (Fld)					<0.01	<0.01
Oxygen (O) (DIS) (Fld)	1.4	2	2	2.6	2.9	1.8
Depth To Water Level (ft)	32.7	32.8	33	33.4	33.6	33.6
pH (Fld)	7	6.8	6.6	7	7.1	7.09
SC (umhos/cm at 25 C) (Fld)	2560	2600	2590	2460	2600	2520
Water Temperature (C) (Fld)	12.3	12.4	12.3	12.4	11.8	12.5

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-9	STW-9	STW-9	STW-9	STW-9	STW-9
Water	SAMPLE DATE	2/14/2002	2/15/2002	2/19/2002	2/22/2002	2/27/2002	4/19/2002
	SAMPLE TIME	14:20	09:30	13:40	10:45	13:05	13:30
	LAB	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	L020101001	L020101006	L020110004	L020118004	L020142009	L020278003
	SAMPLE NUMBER	EHST-0202-700	EHST-0202-800	EHST-0202-903	EHST-0202-103	EHST-0202-208	EHST-0204-102
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						
Common Ions: ppm unless noted							
	Bicarbonate (HCO3)	215	68	220	207	209	211
	Carbonate As CO3	<1	<1	<1	<1	<1	<1
	Sulfate (SO4)	869	1125	911	914	934	967
	Total Alkalinity As CaCO3	176	180	180	170	171	173
Metals: ppm unless noted							
	Arsenic (As) (DIS)	21	20	21	20	21	20
	Arsenic +3			7.3			7.4
	Arsenic +5			13			13
	Cadmium (Cd) (DIS)			<0.001			0.003
	Copper (Cu) (DIS)			0.01			
	Iron (Fe +2)	<0.01	<0.01				
	Iron (Fe) (DIS)	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
	Lead (Pb) (DIS)			<0.005			<0.005
	Manganese (Mn) (DIS)			2.9			2.6
	Zinc (Zn) (DIS)			0.1			0.2
Physical/Fld-Lab: ppm unless noted							
	Oxygen (O) (DIS) (Fld)	3.2	3.3	2.2	2.2	2.5	2.9
	pH			7.9			
	Depth To Water Level (ft)	33.8	33.8	33.8	33.9	34.7	
	pH (Fld)	7	7	7.2	7.2	6.9	7.02
	SC (umhos/cm at 25 C) (Fld)	2500	2640	2650	2520	2380	2820
	SC (umhos/cm at 25 C)			2640			
	Water Temperature (C) (Fld)	12.4	12.2	12.4	12.6	12	12.9

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-9	STW-9	STW-9	STW-9	STW-9	STW-9
Water	SAMPLE DATE	5/10/2002	6/6/2002	8/8/2002	9/26/2002	11/13/2002	6/2/2003
	SAMPLE TIME	00:00	14:30	15:30	16:35	12:00	10:15
	LAB	ASARCO	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC	TSC-SLC
	LAB NUMBER	205108	L020426005	L020638006	L020829007	L020943005	L030245003
	SAMPLE NUMBER	EHST-0205-108	EHST-0206-104	EHST-0208-105	EHST-0209-606	EHC-0211-220	AEH-0306-165
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI	RI	RI
	DESCRIPTION						
	REMARKS						

Common Ions: ppm unless noted

Bicarbonate (HCO3)	203	187	190	217	216
Calcium (Ca) (DIS)	117			135	112
Carbonate As CO3	<1	<1	<1	<1	<2
Chloride (Cl)	196			184	152
Magnesium (Mg) (DIS)	26			29	30
Potassium (K) (DIS)	17			18	13
Sodium (Na) (DIS)	533			440	354
Sulfate (SO4)	1150	972	1013	1092	915
Total Alkalinity As CaCO3	166	153	156	178	177

Metals: ppm unless noted

Aluminum (Al) (DIS)	<0.05			<0.05	
Arsenic (As) (DIS)	17	14	14	15	12
Arsenic +3	12	10	14	9.3	15
Arsenic +5	6	5	1	5.7	<0.005
Cadmium (Cd) (DIS)	<0.001			<0.001	0.001
Copper (Cu) (DIS)	0.01			<0.004	0.007 J
Iron (Fe) (DIS)	<0.02	<0.02	<0.02	<0.02	<0.02
Lead (Pb) (DIS)	<0.005			<0.005	<0.005
Manganese (Mn) (DIS)	3			2.5	2.7
Zinc (Zn) (DIS)	0.2			0.1	0.2

Other: ppm unless noted

Silicon+Silica (Si+SiO2)	27			27	
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Physical/Fld-Lab: ppm unless noted

Oxygen (O) (DIS) (Fld)	2.3	3.6	2.8	2.7	0.2
pH	7.5			7.7	7.3
Depth To Water Level (R)	34.7	33.9	29.6	31.2	32.06
pH (Fld)	6.9	6.7	7	7.1	6.5
SC (umhos/cm at 25 C) (Fld)	2750	2900	2520	2630	2350
SC (umhos/cm at 25 C)	2780			2710	2440
Total Suspended Solids	10			8	9.6
TDS (Measured at 180 C)	2027			1958	1721
Salinity (G/KG) (Fld)					1.1
Turbidity (NTU) (Fld)					3
Water Temperature (C) (Fld)	13.5	12.4	12.3	12	12.1

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB

ASARCO, East Helena Plant

Sample Matrix	STATION	STW-9	STW-9	STW-9	STW-9
Water	SAMPLE DATE	10/30/2003	10/30/2003	5/20/2004	5/20/2004
	SAMPLE TIME	09:45	10:00	10:40	10:40
	LAB	TSC-SLC	TSC-SLC	ELI	ELI
	LAB NUMBER	L030605017	L030605018	H04050133-004	H04050133-005
	SAMPLE NUMBER	AEH-0310-440	AEH-0310-441	AEH-0405-127	AEH-0405-128
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RJ	RJ	RJ	RJ
	DESCRIPTION				
	REMARKS		Field Duplicate		Field Duplicate

Common Ions: ppm unless noted

Bicarbonate (HCO3)	234	234
Calcium (Ca) (DIS)	125	128
Carbonate As CO3	<2	<2
Chloride (Cl)	121	129
Magnesium (Mg) (DIS)	28	29
Potassium (K) (DIS)	14	15
Sodium (Na) (DIS)	325	331
Sulfate (SO4)	816	782
Total Alkalinity As CaCO3	192	192

Common Ions (mg/L): ppm unless noted

Bicarbonate (HCO3)	210	210
Calcium (Ca) (DIS)	138	137
Chloride (Cl)	110	120
Magnesium (Mg) (DIS)	30	29
Potassium (K) (DIS)	17	17
Sodium (Na) (DIS)	290	290
Sulfate (SO4)	810	790
Total Alkalinity As CaCO3	170	170

Metals: ppm unless noted

Arsenic (As) (DIS)	12	12
Arsenic +3	3.2 J	2.2 J
Arsenic +5	8.2	10
Cadmium (Cd) (DIS)	<0.001	<0.001
Copper (Cu) (DIS)	0.007	0.007
Iron (Fe) (DIS)	<0.03	<0.03
Lead (Pb) (DIS)	<0.005	<0.005
Manganese (Mn) (DIS)	3.4	3.5
Zinc (Zn) (DIS)	0.2	0.2

Metals (mg/L): ppm unless noted

Arsenic (As) (DIS)	7.608	8.213
Arsenic +3	0.043 J	<0.006 J
Arsenic +5	15 J	10 J
Cadmium (Cd) (DIS)	<0.001	<0.001
Copper (Cu) (DIS)	0.005	0.005
Iron (Fe) (DIS)	<0.02	<0.02
Lead (Pb) (DIS)	<0.005	<0.005
Manganese (Mn) (DIS)	4.16	4.11
Zinc (Zn) (DIS)	0.21	0.21

Physical/Fld-Lab: ppm unless noted

Oxygen (O) (DIS) (Fld)	0.29	
Oxygen (O) (DIS) (Fld) (DIS)		0.28

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

East Helena Sparge Project

ANALYSES SUMMARY REPORT

C:\EnviroDataDB\Databases\V5_B_DB\EastHelena.MDB
ASARCO, East Helena Plant

Sample Matrix	STATION	STW-9	STW-9	STW-9	STW-9
Water	SAMPLE DATE	10/30/2003	10/30/2003	5/20/2004	5/20/2004
	SAMPLE TIME	09:45	10:00	10:40	10:40
	LAB	TSC-SLC	TSC-SLC	ELI	ELI
	LAB NUMBER	L030605017	L030605018	H04050133-004	H04050133-005
	SAMPLE NUMBER	AEH-0310-440	AEH-0310-441	AEH-0405-127	AEH-0405-128
	TYPE	Groundwater	Groundwater	Groundwater	Groundwater
	GROUP	RI	RI	RI	RI
	DESCRIPTION				
	REMARKS		Field Duplicate		Field Duplicate

Physical/Fld-Lab: ppm unless noted

pH	7.8	7.8	7.2	7.3
Depth To Water Level (ft)	31		32.59	
pH (Fld)	6.36		6.24	
SC (umhos/cm at 25 C) (Fld)	2290		2150	
SC (umhos/cm at 25 C)	2320	2320	2220	2330
Total Suspended Solids	26 J	56 J	16	21
TDS (Measured at 180 C)	1697	1691	1540	1550
Salinity (G/KG) (Fld)	1		1	
Turbidity (NTU) (Fld)	21		0.0	
Water Temperature (C) (Fld)	11.9		12.8	

TOT: Total; DIS: Dissolved; TRC: Total Recoverable

NOTE: Table 1 lists data validation flagging descriptions.

APPENDIX D

BENCH SCALE TESTING SUMMARY

**INTERIM MEASURES - AIR SPARGING
SUMMARY OF BENCH TEST RESULTS AND
UPCOMING PILOT SCALE TESTING
SEPTEMBER 2001**

The following information is provided as an interim deliverable to update EPA on recent air sparging bench-scale test results, and to describe upcoming field activities relating to the air sparge testing being performed at the Asarco East Helena Plant. A more comprehensive report will be prepared as a final deliverable pending the results of pilot-scale testing.

Two previous air sparge pilot tests were conducted on the site during 2000 (Phase I & II). The first test (Phase I) utilized sparge wells 1 & 2 (SPAR-1 and SPAR-2 on Figure 1), located near the northern boundary of the plant site in the area downgradient of the former speiss handling facilities. A second test (Phase II) was conducted at sparge well 3 (SPAR-3; Figure 1), which is approximately 125 feet west of the first test site. Water quality at SPAR-3 is generally similar to that at SPAR-1 and SPAR-2, but contains higher concentrations of dissolved iron. Both tests were successful at converting the primary dissolved arsenic species from the +3 to the +5 valence state; however, the second test showed a much more significant reduction in groundwater dissolved arsenic concentrations, presumably due to coprecipitation and/or adsorption of arsenic with precipitated iron. Results of the Phase I & II testing were documented in a prior report to EPA (Hydrometrics, 2000).

Bench Scale Testing

Following the completion of the Phase II testing, additional bench-scale testing was conducted to assess whether it is potentially feasible to introduce soluble iron to the groundwater system in the air sparging area, thereby enhancing iron precipitation and arsenic removal during sparging. A series of batch tests and column tests were conducted with the following objectives:

1. Assess the solubility of various iron reagents in groundwater from the site.
2. Evaluate iron attenuation by site soils.
3. Evaluate the effect of varying iron concentrations on groundwater pH.
4. Evaluate the effect of iron concentrations and pH on iron/arsenic removal rates.
5. Evaluate time required for iron/arsenic precipitation.
6. Evaluate the stability of arsenic-bearing iron precipitates.

Table 1 presents a summary of the bench-scale test results, including a brief summary of the objectives, procedures, results and conclusions for each test. Additional tables and graphs are attached which present supporting data.

The bench scale test showed that:

1. Ferrous sulfate appears to be an acceptable reagent. It is soluble in groundwater with only small amounts of iron precipitating after initial dilution in groundwater. Adding a small amount of reducing agent (sodium hydrosulfite) eliminates precipitates that might eventually result in plugging of the injection well.
2. The site soils have a high iron adsorption capacity under ambient redox conditions. This will slow the dispersion of any introduced iron into the groundwater system. High pH reduces iron attenuation rates (i.e., iron becomes more mobile as pH decreases).
3. Reagent dosages to yield iron concentrations of 200 mg/L or greater began to significantly decrease the pH of the mixed reagent/groundwater solution ($\text{pH} < 6$).
4. 10% to 90% of arsenic was removed during sparging when dissolved iron was added to groundwater. This is similar to field results from previous testing. Higher initial iron concentrations produced lower arsenic concentrations after sparging. However, iron concentrations higher than 200 mg/L depressed the pH and resulted in a decrease in the rate of arsenic removal.

5. Reaction rates were relatively rapid. Increases in the duration of air sparging beyond 24 hours produced only minor additional arsenic removal.
6. When soil from a test column was leached, approximately 12% of the adsorbed arsenic was remobilized.

Based on these results, injection of ferrous sulfate followed by air sparging may produce desirable results. However, pH effects and attenuation of iron in the soils will need to be considered.

Phase III Pilot-Scale Testing

A Phase III pilot test will begin in September 2001. The objectives of this test are to provide a more long-term evaluation of sparging at the SPAR-3 site, and to test iron introduction methods and results at the SPAR-1 & -2 wells. Sparging will initially be conducted at both sites without iron introduction. After approximately 30 days of operation (to achieve steady-state conditions), iron will be introduced at the SPAR-1 & -2 site through monitoring well STW-7 (located approximately 25 feet upgradient of SPAR-1 & -2; Figure 1). A ferrous sulfate solution will be introduced at relatively low rates (i.e. 0.03 gal/min) while monitoring the dissolved iron, pH and redox response in monitoring wells immediately downgradient. The objective is to increase dissolved iron concentrations in downgradient groundwater without significantly decreasing pH. Since the soils have a net neutralizing capacity, they will tend to buffer changes in pH. Wells downgradient of the sparge system will be monitored in the field to assess changes in pH, conductivity, redox and dissolved iron. Periodic samples will also be collected for analysis of metals and other water quality indicators. A generalized sampling schedule and parameter list is shown in Table 2. Sampling and analytical procedures will follow protocol established for the Phase I and Phase II testing (Hydrometrics, 2000). The attached sampling schedule is preliminary and will need to be adjusted based on the monitoring results. Weekly field monitoring of pH, SC, redox and iron will provide a basis for tracking the progress of the injected ferrous sulfate solution in the groundwater system. The monitoring schedule will be re-evaluated regularly based on these weekly

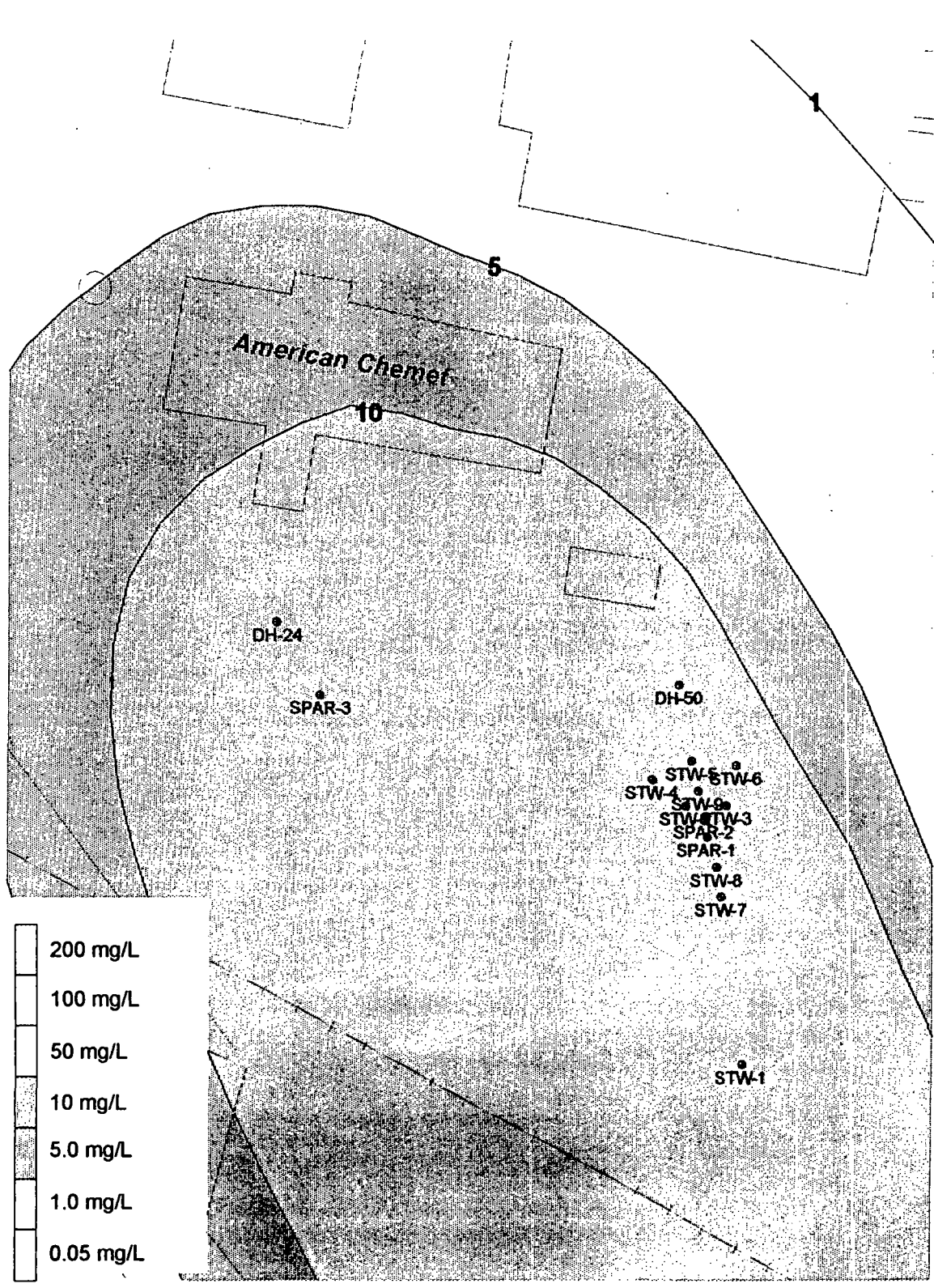
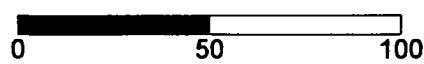
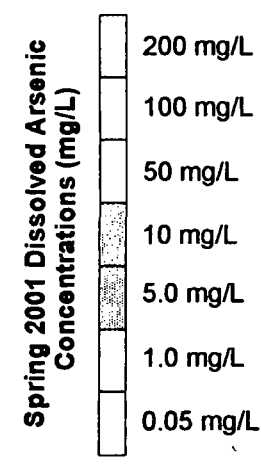
results. The Phase III test will be conducted for approximately a 3 month period, as originally proposed.

References

Hydrometrics, 2000. Interim Measures Air Sparging Pilot Test Report (December 2000).

ATTACHMENT 1

➤ FIGURE 1 – MONITORING WELLS AND AIR SPARGING WELLS LOCATIONS



**ASARCO EAST HELENA
PHASE III PILOT TEST**

**MONITORING WELLS AND
AIR SPARGING
WELL LOCATIONS**

FIGURE

1

ATTACHMENT 2

- **TABLE 1 – SPARGE BENCH TEST SUMMARY**
- **SUPPORTING TABLES AND FIGURES**

Table 1 -- Sparge Bench Test Summary

Test	Purpose	Procedure	Results	Conclusions
Test 1	Evaluate Iron Reagents			
1A	Determine whether a ferrous sulfate reagent is stable in ambient groundwater	Mixed up 1% solution of ferrous sulfate. Added 3 different doses of iron reagent to groundwater samples, sealed in air-tight containers, and monitored iron concentrations over time.	Visible iron ppt formed, but majority of iron remained in solution. (Table 1A)	Dissolved iron concentrations appear stable over time. Average % ferrous iron in solution for 3 doses was 88% at 16 hours, 89% at 4 days, and 84% at 7 days. Visible solids are precipitated with the addition of reagent is significant, but amount does not appear to be a function of the quantity of iron introduced.
1B	Determine whether the iron precipitate in reagent mixed with groundwater is due to the presence of some dissolved oxygen in the groundwater	Made 1% solution of sodium hydrosulfite. Added to groundwater to reduce oxygen below 1 ppm and then added 700 ppm dose of iron (using 1% ferrous sulfate solution).	Visible iron ppt still formed. Results similar to 1A. (Table 1B)	Dissolved oxygen in the groundwater does not appear to be a major factor in precipitation.
1C	Determine whether oxidation of reagent is due to presence of dissolved oxygen in solvent (DI)	Took a 710 mL sample of deionized water (DI) and added enough of 1% sodium hydrosulfite solution to reduce oxygen below 1 ppm. Added 35.5 g of ferrous sulfate to make a 1% iron solution.	Visible iron ppt still formed. Results similar to 1A. (Table 1C)	Dissolved oxygen in DI does not appear to be a major factor in reagent oxidation.
1D	Determine if ferric can be reduced to ferrous in samples and increase ferrous ratios	Added hydroxyl amine and sodium hydrosulfite (reducing agents) to different reagent samples and compared iron results.	Decreased quantity of solids precipitated in reagent. (Table 1D)	Adding reducing agents to groundwater does not appear to greatly improve the ferrous ratio. However, adding reducing agents does appear to decrease the solids precipitated in the reagent solution.
1E	Determine if the addition of a reduced iron solution (above) will decrease precipitation in ambient groundwater	Used 1% Fe solution w/ 2 g of sodium hydrosulfite to add 700 ppm dose of reagent to groundwater sample.	Decreased quantity of solids precipitated in groundwater. (Table 1E)	Adding a reduced reagent solution to groundwater greatly decreases amount of solids precipitated by groundwater.
1F	Determine if the quality of reagent solution significantly changes with solvent used	Made 1% Fe solution using DI, East Helena City water and Upper Lake water.	Similar results for East Helena City Water and Upper Lake Water. (Table 1F)	Either water source is acceptable for mixing reagents.
1G	Determine if the type of reagent used significantly changes reagent solution water quality	Made 1% Fe solution using (1) Citric Acid Complex (CAC) or (2) REAX® as complexing agents, with East Helena City Water as makeup water.	CAC-iron solution has lower percent ferrous and much lower pH. REAX® reagent makes water very black, otherwise similar to ferrous sulfate. (Table 1G)	Alternative reagents showed no advantages over ferrous sulfate.
Test 2	Evaluate Iron Attenuation by Site Soils			
2	Establish attenuation rates for iron in native soils at test site.	Prepared 1% Fe solution with 1.5 g of sodium hydrosulfite. Using groundwater made solutions at 70 ppm Fe, 700 ppm Fe and 2100 ppm Fe. 37 g of prepared soil was added to each solution. Two representative soils (sand & silty sand) were tested. Control samples were also prepared without soil. Bottles were placed on bottle roller. Samples were collected and analyzed after 24 hrs and 60 hrs.	For the silty sand (Sample 1) 750-4100 mg of Fe were removed per kg of soil. For the sand (Sample 2) 430-2200 mg of Fe were removed per kg of soil. Calculated Kd's ranged from 2-59 mg/g for Sample 1 and 1-15 mg/g for Sample 2. The higher range Kd's were calculated for solutions with lower iron concentrations. (Table 2, Figure 2.1, Figure 2.2)	Soils show high Fe attenuation rates. Virtually all of the iron was adsorbed when introduced at low concentrations. Adsorption was relatively rapid with only minor increases in Fe removal after 24 hours. A drop in pH (5.5-6.5) was observed at higher iron concentrations.
Test 3	Evaluate Sparging Effects			

Table 1 -- Sparge Bench Test Summary

3A	Evaluate % iron and arsenic removal given various initial concentrations	Groundwater solutions prepared as per test 2A at concentrations of 10, 50, 100 & 200 ppm Fe. After sealing bottles and rolling for 24 hrs per test 2 protocol, the sample were then placed in open jars and stirred at 150 rpm for 24 hours to allow DO to equilibrate with atmosphere. Samples were then analyzed for pH, SC, DO, iron and arsenic.	32% to 99% of the iron was adsorbed or precipitated from solution after the reagent equilibrated with the soils and prior to sparging. After sparging 80% to 100% of the iron was removed from solution. There was a decrease in pH (5.8-6.2) in samples with an initial iron concentration of 200 mg/L. 10%-90% of the arsenic was removed from solution during sparging. (Table 3, Figures 3A.1 - 3A.6)	High arsenic removal rates were associated with greater initial iron concentrations. The pH effects in samples with 200 mg/L iron appeared to decrease iron oxidation & limit removal rates.
3B	Repeat 3A for longer "sparge interval" to evaluate effect of time on removal efficiencies	Test 3A was duplicated for groundwater solutions containing 50 and 200 ppm Fe and soil Sample 2 (sand). Samples were exposed to high DO conditions for a longer time interval. Samples were analyzed after 1 day and 5 days of "sparging".	70 to 98% of the iron was adsorbed or precipitated from solution after sparging and 13%-88% of the arsenic was removed. The majority of the removal (85%-95%) of iron and arsenic was in the first 24 hours. 1 - 4 mg of iron were removed for each mg of arsenic. pH decreased to 6 at higher iron dose. (Figures 3B.1-3B.5)	Results were similar to 3A. Continued sparging after the first day produced very limited additional removal. Lower iron doses resulted in higher Fe:As removal ratios, but less total reduction. At higher iron doses pH decreases, reducing removal efficiency.
Test 4	Column Testing			
4A	Further evaluate iron adsorption characteristics of soil	Placed 20 gallons of groundwater from STW-1 in drum and added 4.28 g of sodium hydrosulfite and 76 g of ferrous sulfate heptahydrate (200 ppm dose) and mixed thoroughly with drum mixer. A 3" ID x 22" column with 5 evenly spaced sample ports was packed with soil collected during well drilling at East Helena. A low-flow peristaltic pump with adjustable flow rate was used to pump the iron-dosed groundwater into that column at ~1 mL/min. Every 24 hours, the influent and all sample ports were analyzed for iron concentration.	The column initially removed 99% of the dissolved iron, decreasing to 30% removal over a 13 day period. The soil column attenuated 358 mg of iron per kilogram of soil during the test. The test yielded a Kd for iron of approximately 2 ml/g. (Figure 4A)	Iron attenuation in the soil column was significant, but less than indicated by batch tests.
4B	Evaluate arsenic removal with introduction of sparged water	After loading the column with an iron solution in Test 4A, aerated groundwater was introduced to the column in Test 4B. Daily influent and effluent samples were collected and sent to a lab to be analyzed for iron, arsenic, lead, cadmium, and zinc concentrations. The test was run over a 3 week period.	Initially the column showed attenuation rates for arsenic of 72% decreasing to 9% over a 17 day period. Approximately 6.6 milligram of iron was removed for each milligram of arsenic removed. (Figure 4B)	This test introduced oxygenated water to soils with adsorbed iron. Iron to arsenic removal rates were somewhat lower than in batch tests where dissolved iron was removed from solution with arsenic rather than adsorbed iron.
Test 5	Arsenic Leachability			
5	Rinse soil column after 4B test	After completing test 4B the soil column was allowed to gravity drain and then Upper Lake water was introduced at a rate of approximately 1 pore volume per day (0.5ml/min). Discharge from the column was analyzed for dissolved iron and arsenic daily over a 7 day period.	Arsenic concentrations in effluent were initially 21 mg/L declining to 6 mg/L over a 7 day period. Twelve percent of the total arsenic attenuated in the column during Test 4B was remobilized after 7 pore volumes of water were exchanged. (Figure 5.1)	Test compares arsenic adsorbed during test 4B to dissolved arsenic after introduction of freshwater. Although some arsenic remobilization is indicated, results may be skewed by residual arsenic on plant site soils due to historical plant site loading that was not accounted for in this test. This effect may be significant due to the large amount of soil in the column.

7/5/2001 Collected groundwater sample from STW-1

pH	6.94	Fe+2	0.02 mg/L
DO	0.42 mg/L	Alkalinity	200 mg/L as CaCO3
Temp	14.2 C		

7/6/2001 Made up 1% Fe solution using EH city water

24.98 g FeSO4.7H2O
500 mL solution
1.00% solution

pH	2.59
Fe+2	8000 mg/L

Made up 500 mg/L Fe solution of Fe reagent dosed into STW-1 groundwater

62.5 mL Fe reagent
937.5 mL groundwater

pH	3.19
Fe+2	550 mg/L
DO	6.95 mg/L

Sparged solution for about 90 minutes

pH	3.13
Fe+2	490 mg/L
DO	6.98 mg/L

Begin adding groundwater to 1L of 500 mg/L Fe mixture in 200 mL increments

GW Added	pH	Fe+2	Comments	Theoretical Fe+2 based on Dilution only (no precip)
200	4.63	410	Orange color appears	408
400	5.34	310	pH drifting down slowly	350
600	5.57	280		306
800	5.7	290		272
1000	5.79	240	1:1 dilution	245

Sparged mixture for about 15 minutes

pH	5.81
Fe+2	250 mg/L

Using 1 liter of 1:1 solution, began adding dropwise NaOH to increase pH, adding about 2 mL at a time. pH increases to about 5.8-5.9, then slowly decreases to 5.6-5.7 with each addition. Sparging during NaOH addition. Orange ppt increases significantly. Remeasured Fe+2 after adding about 10 mL total NaOH:

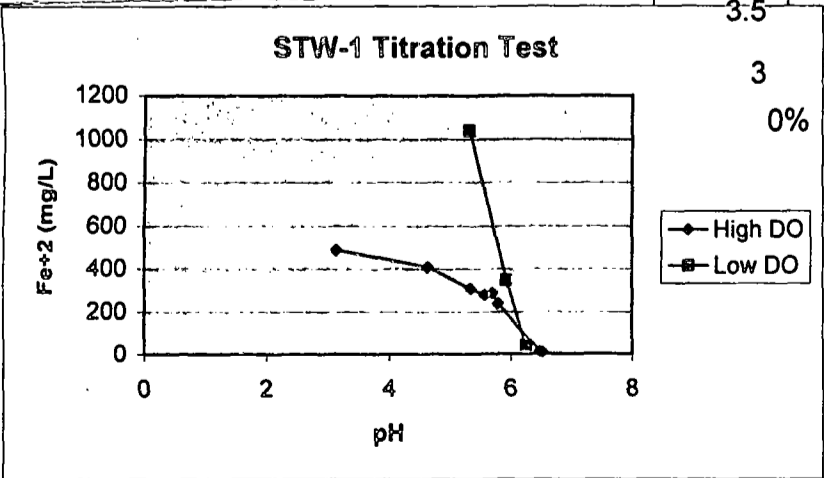
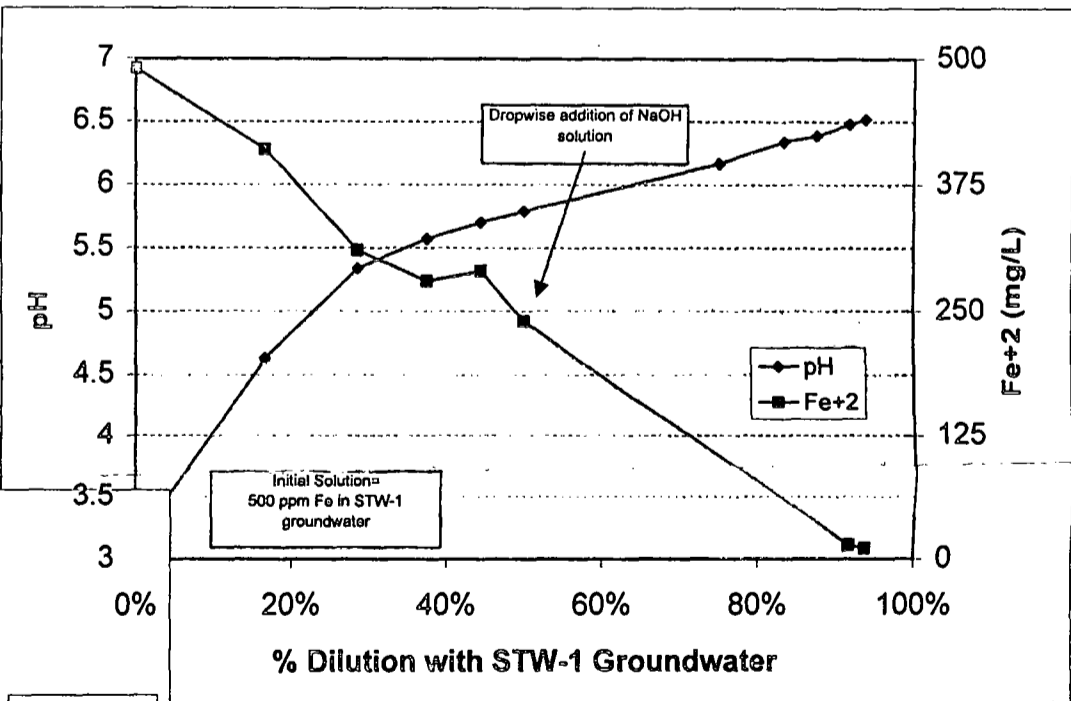
pH	5.5 and dropping
Fe+2	180 mg/L

After about 20 min, pH has dropped to 4.19

7/9/2001 Begin with 100 mL of 1:1 dilution, treated with NaOH, allowed to settle.

GW Added	pH	Fe+2	Theoretical Fe+2 based on Dilution only (no precip)
0	4.08	112	112
100	6.17		56
200	6.34		37
300	6.39		28
500	6.48	14	19
700	6.52	11	14

% Dilution	pH	Fe+2	
0%	3.13	490	
17%	4.63	410	
28%	5.34	310	
38%	5.57	280	
44%	5.7	290	
50%	5.79	240	
50%			Caustic addition
75%	6.17		
83%	6.34		
88%	6.39		
92%	6.48	14	
94%	6.52	11	



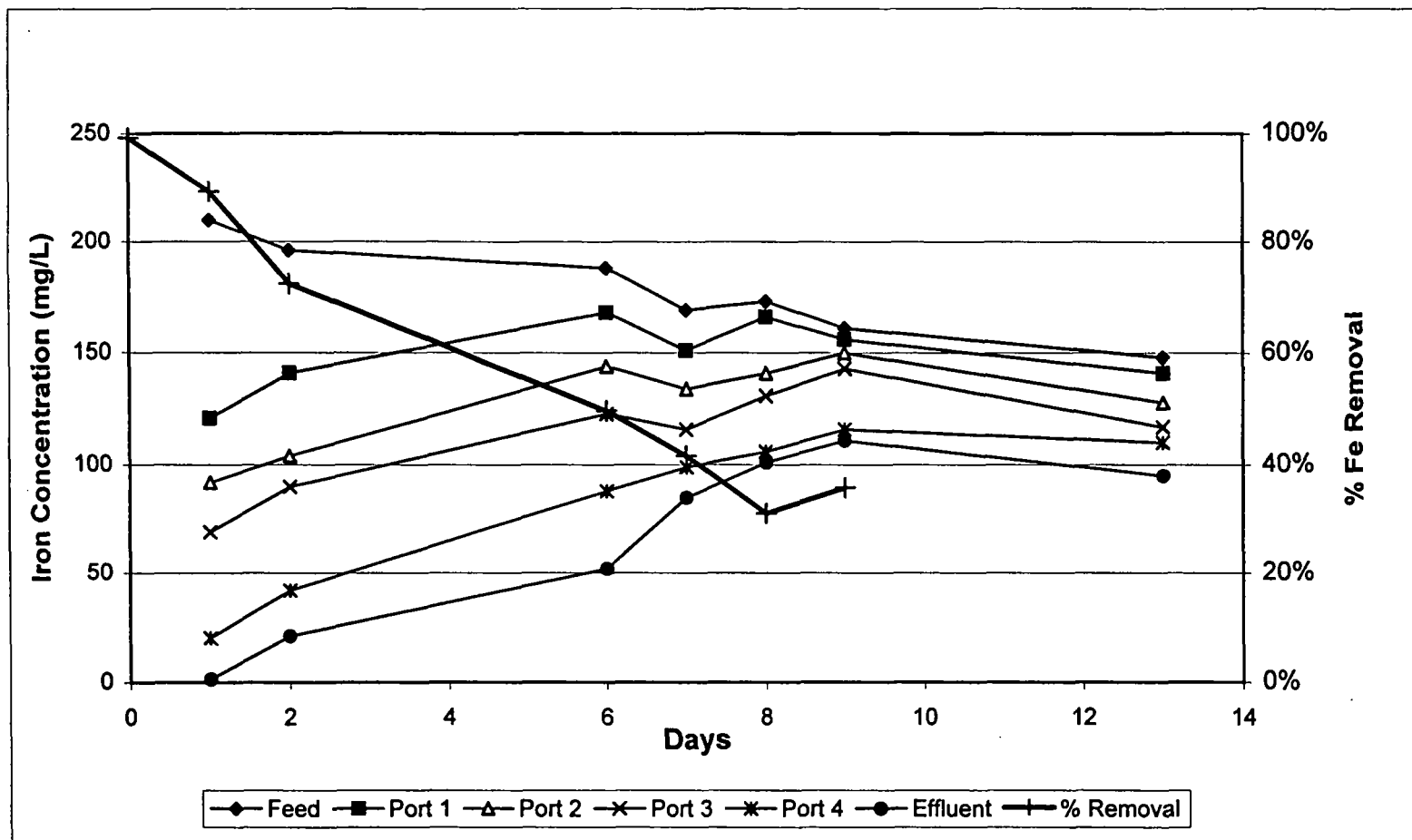


FIGURE 4A: IRON ADSORPTION COLUMN TEST

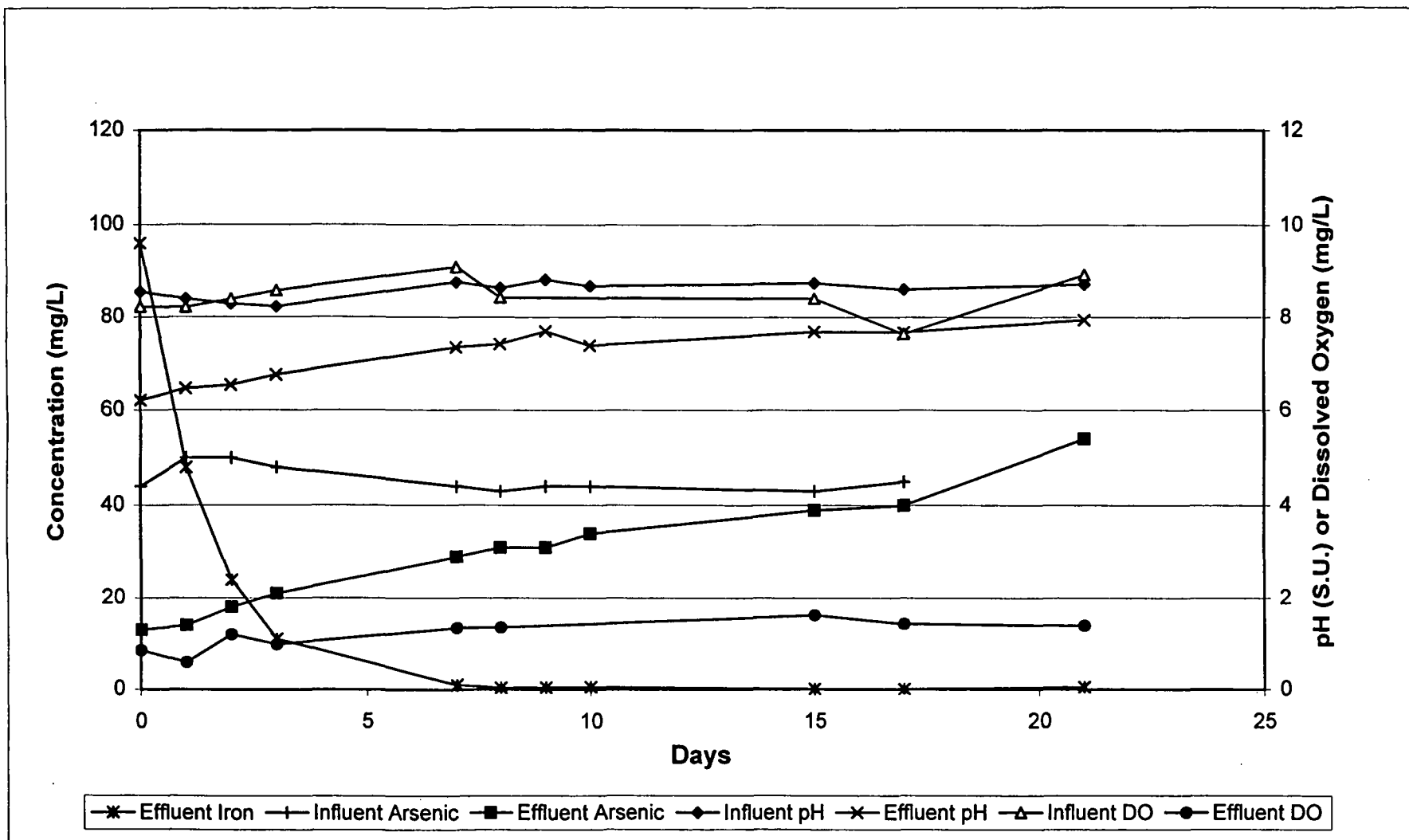


FIGURE 4B. SPARGE COLUMN TEST

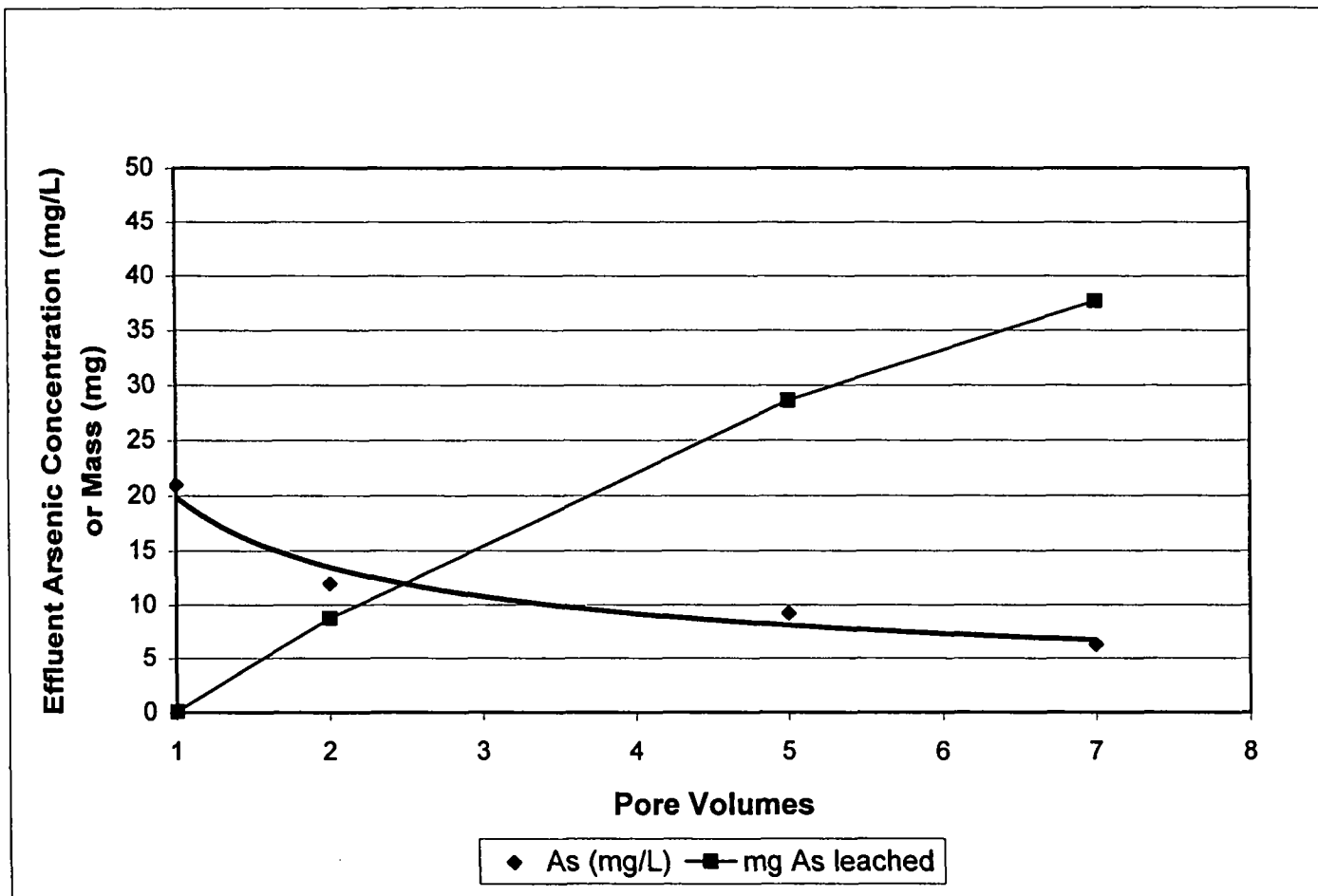


FIGURE 5.1: COLUMN LEACH

REPEATABILITY TESTING - DETERMINE ACCURACY AND PRECISION OF ANALYTICAL METHOD

Dilution - 100:1

Test	Fe (T)	Fe (+2)
1	216	120
2	218	130
3	220	138

Dilution - 500:1

Test	Fe (T)	Fe (+2)
1	635	485
2	615	505
3	615	460

Dilution - 1000:1

Test	Fe (T)	Fe (+2)
1	1750	1310
2	1780	1410
3	1760	1320

Standard: 1,000 ppm

500:1 dilution

Fe (T)	1020
Fe (+2)	20

Figure 3B.5 - Test 3B Iron Results

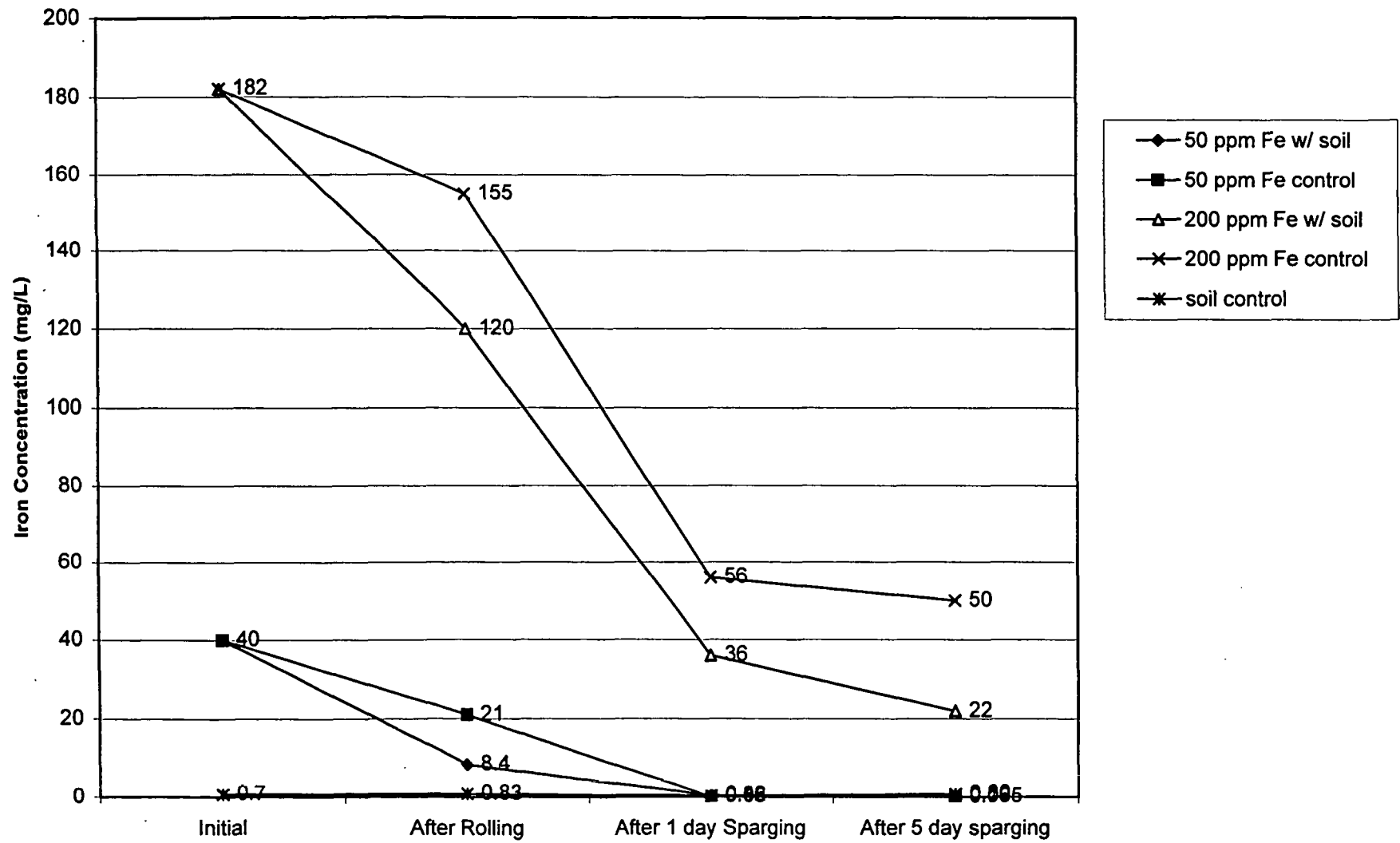


Figure 3B.4 - Test 3B Arsenic Results

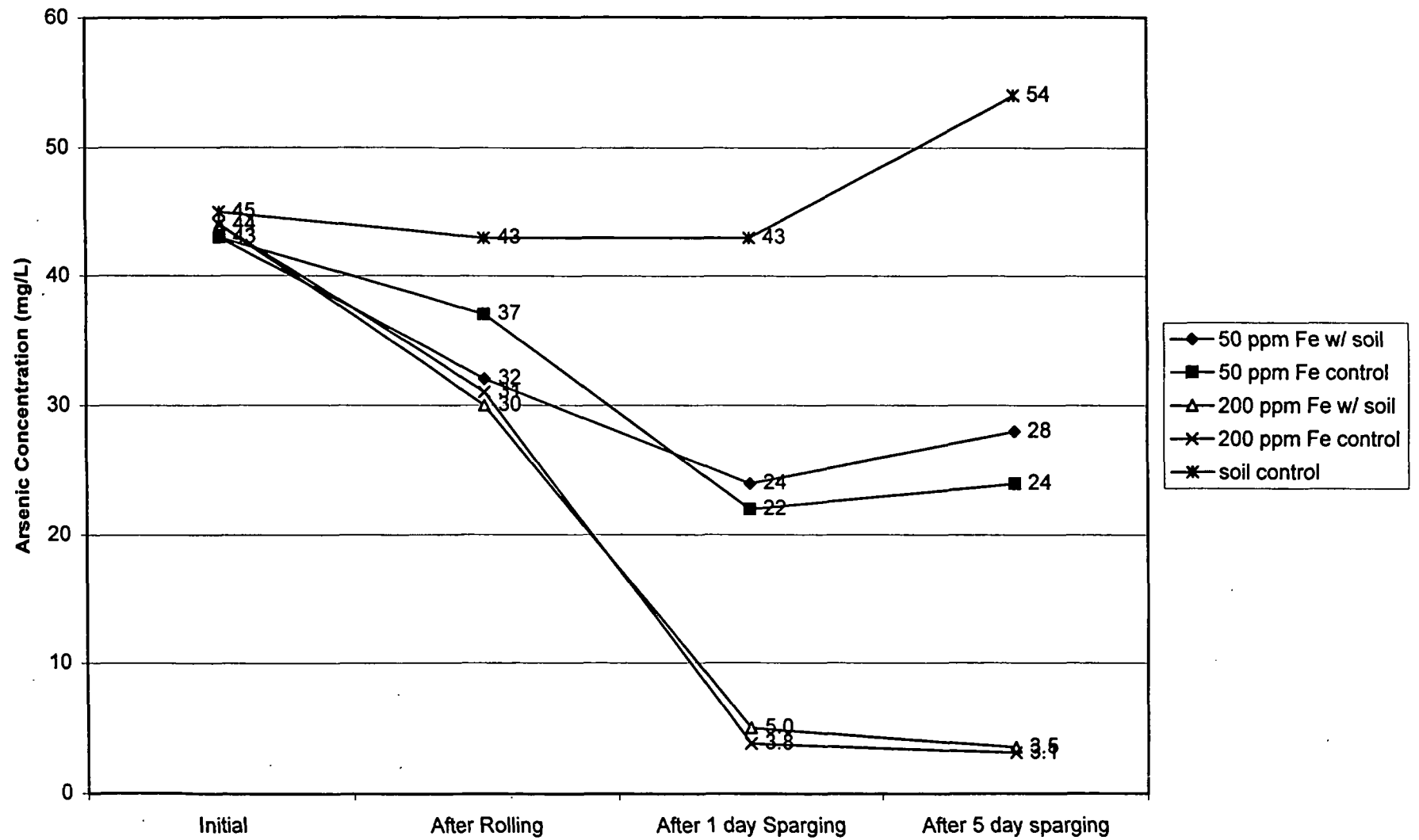
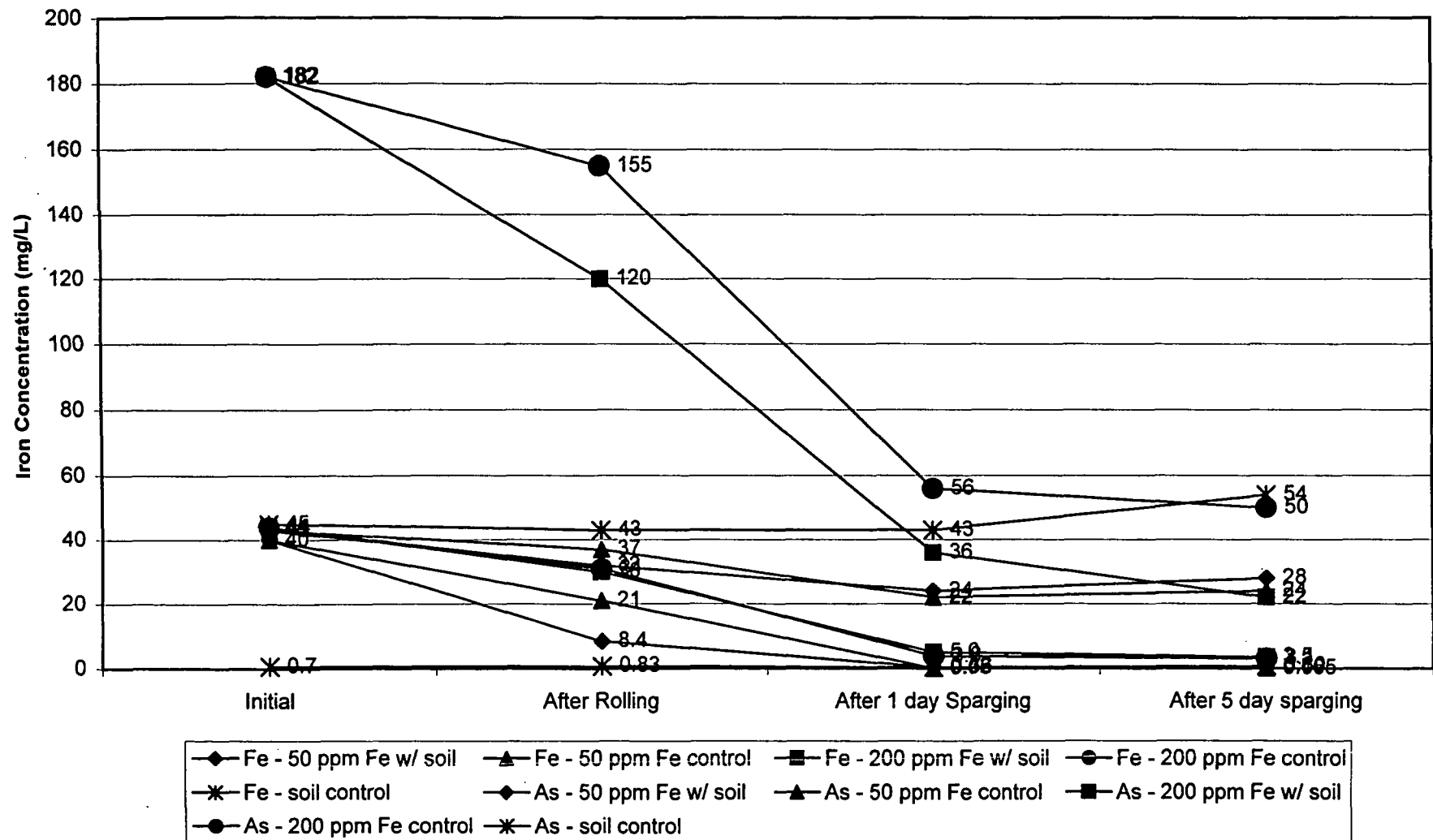


Figure 3B.3 - Test 3B Iron and Arsenic Results



TEST 3B RESULTS

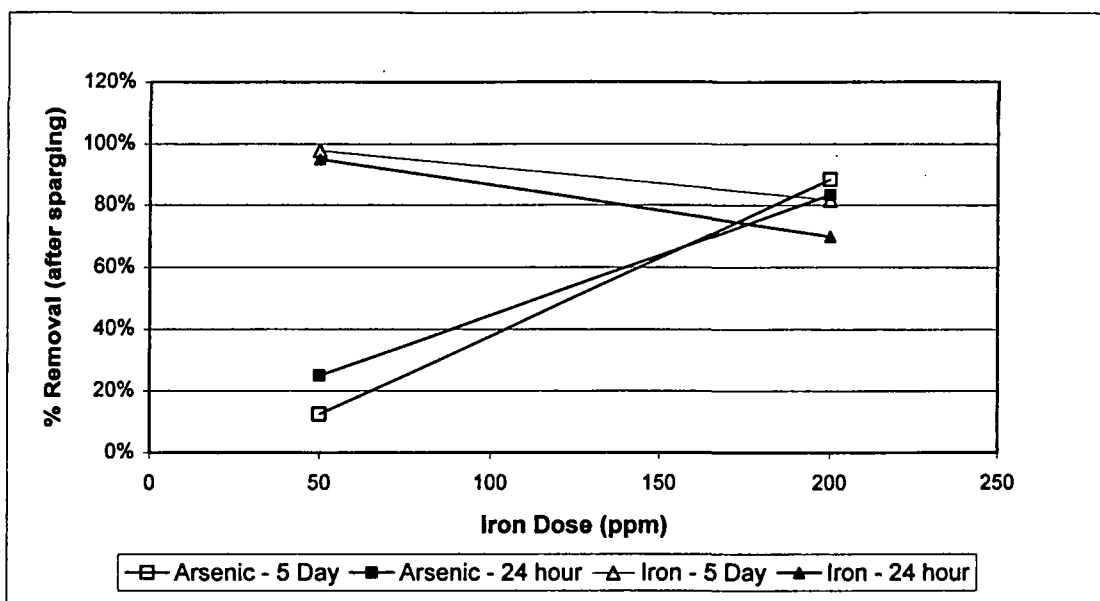


FIGURE 3B.1: IRON AND ARSENIC REMOVAL WITH INCREASED SPARGE INTERVAL

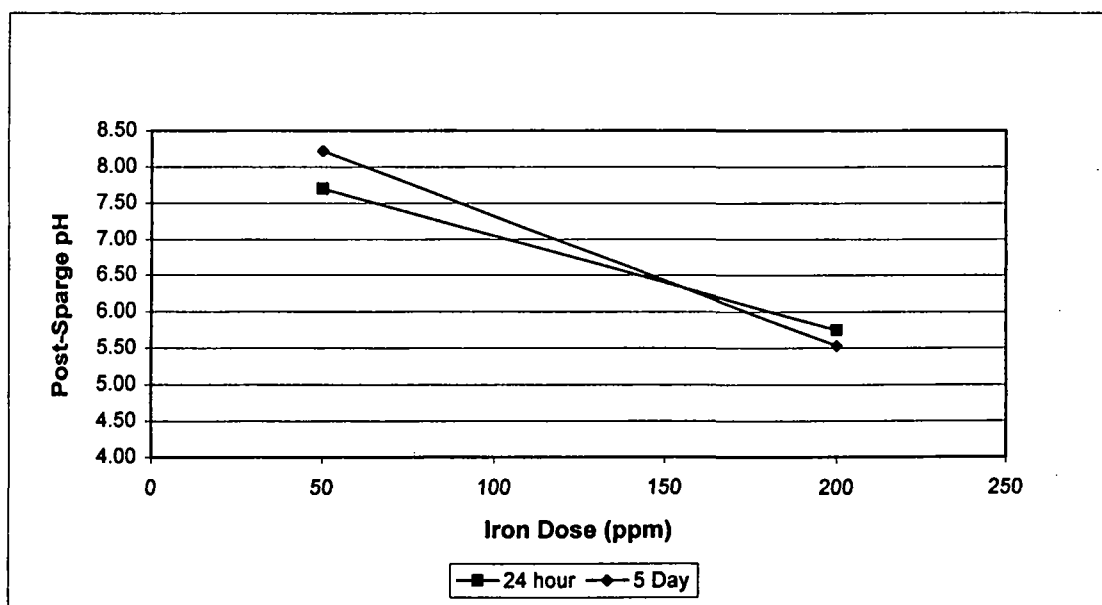


FIGURE 3B.2: pH TRENDS WITH INCREASED SPARGE INTERVAL

Figure 3A.6 - Test 3A Iron Results - Sample 1 (Silty Sand)

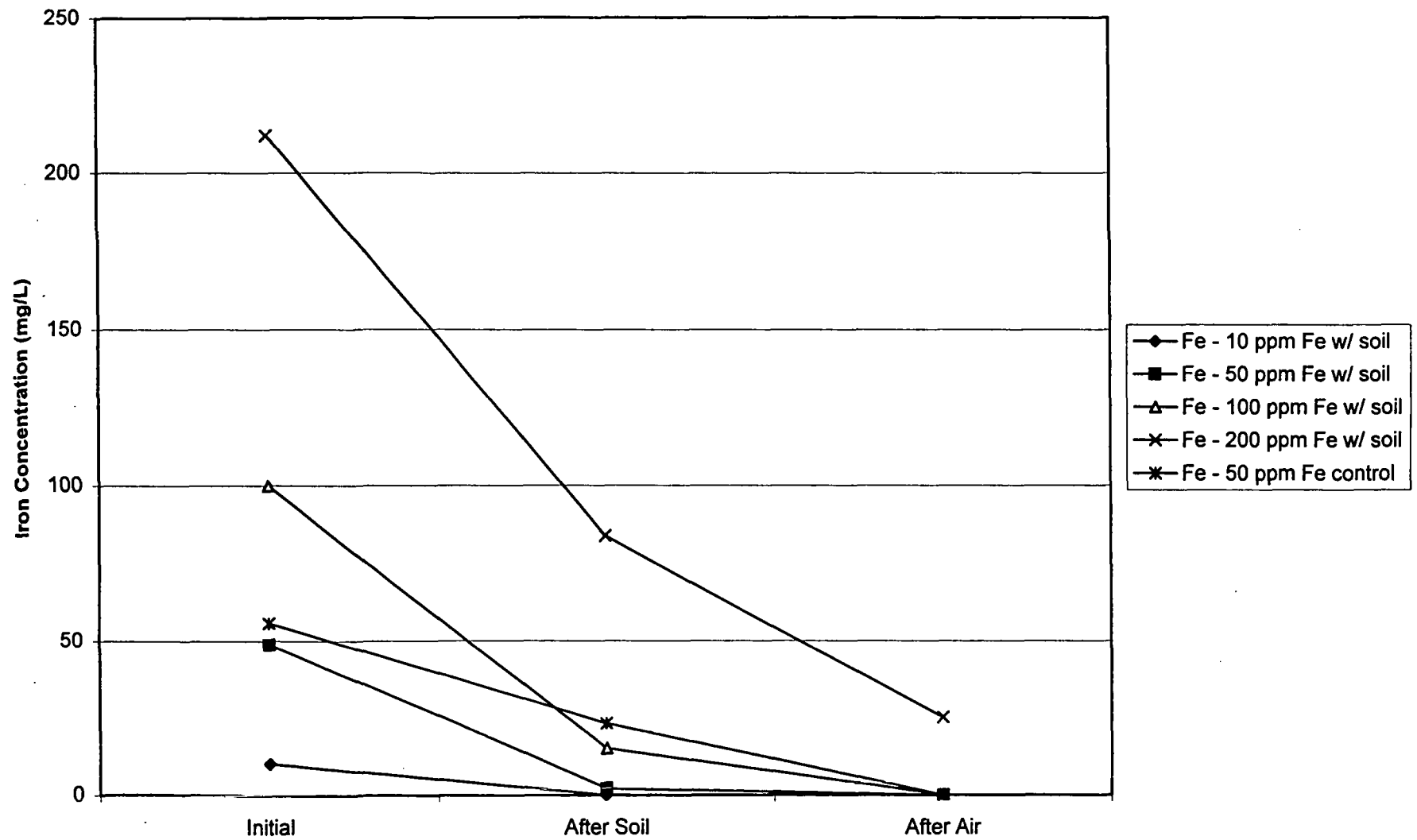


Figure 3A.5 - Test 3A Arsenic Results - Sample 1 (Silty Sand)

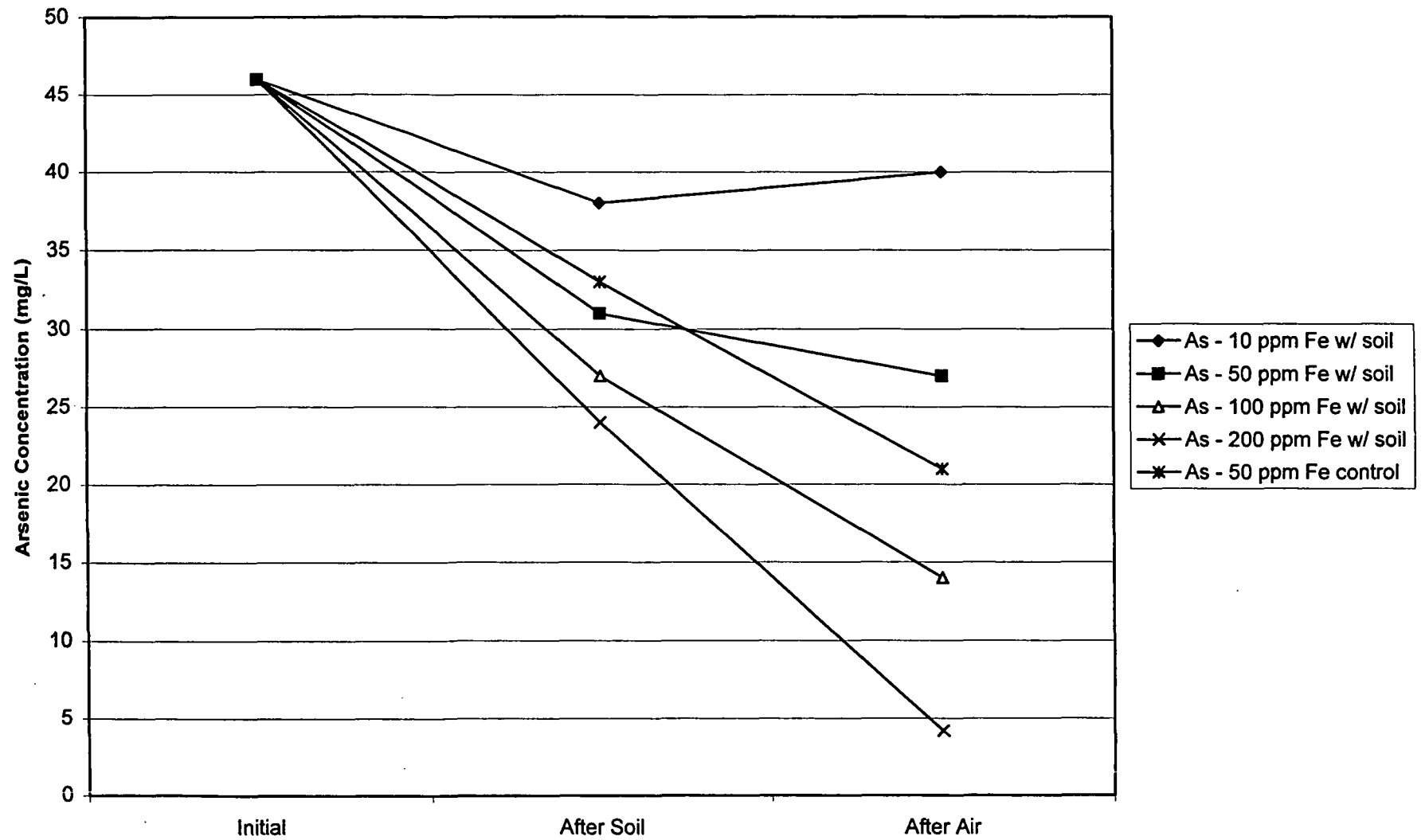


Figure 3A.4 - Test 3A Iron and Arsenic Results - Sample 1 (Silty Sand)

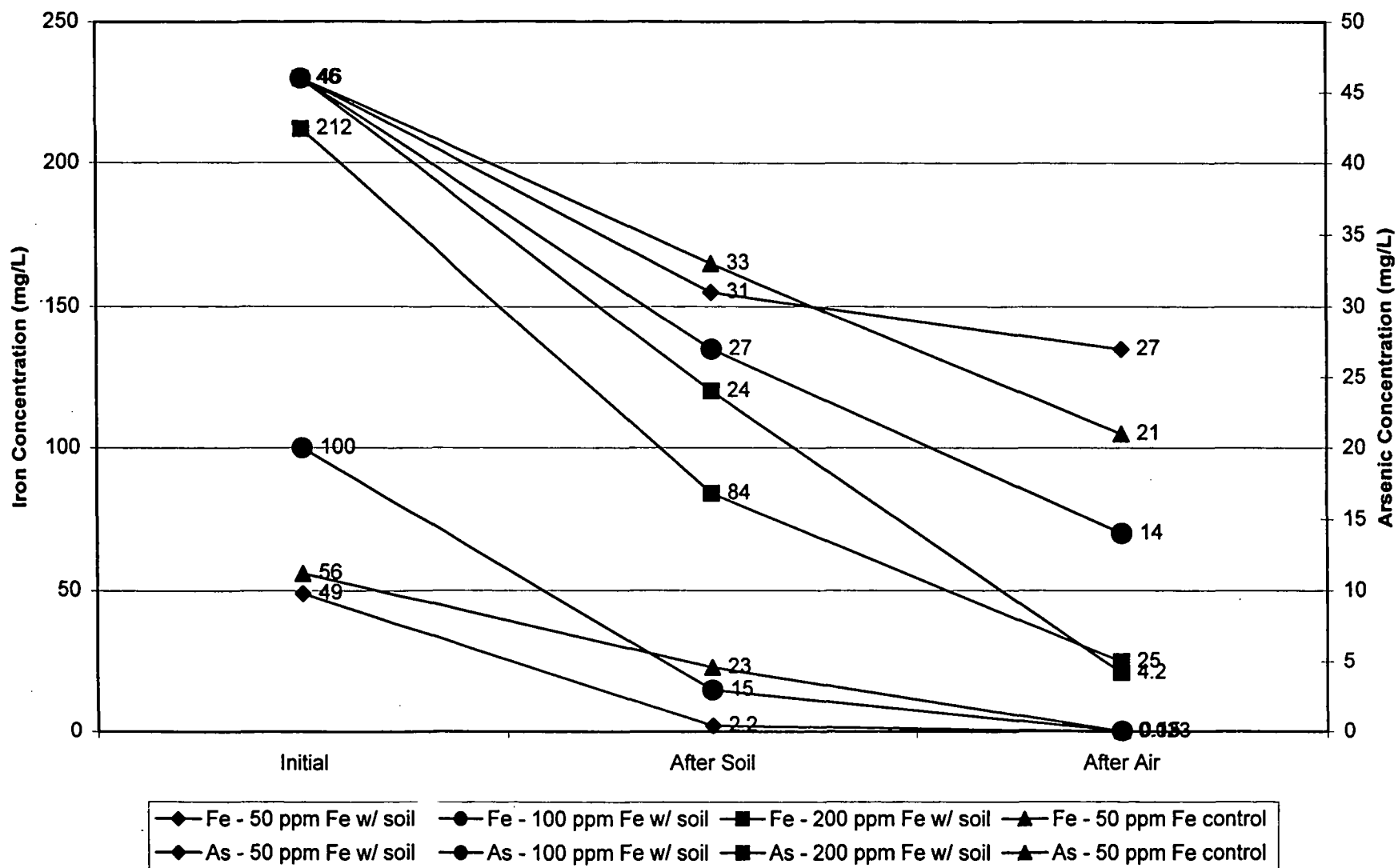


Figure 3A.3 - Test 3A Iron Results - Sample 2 (Sand)

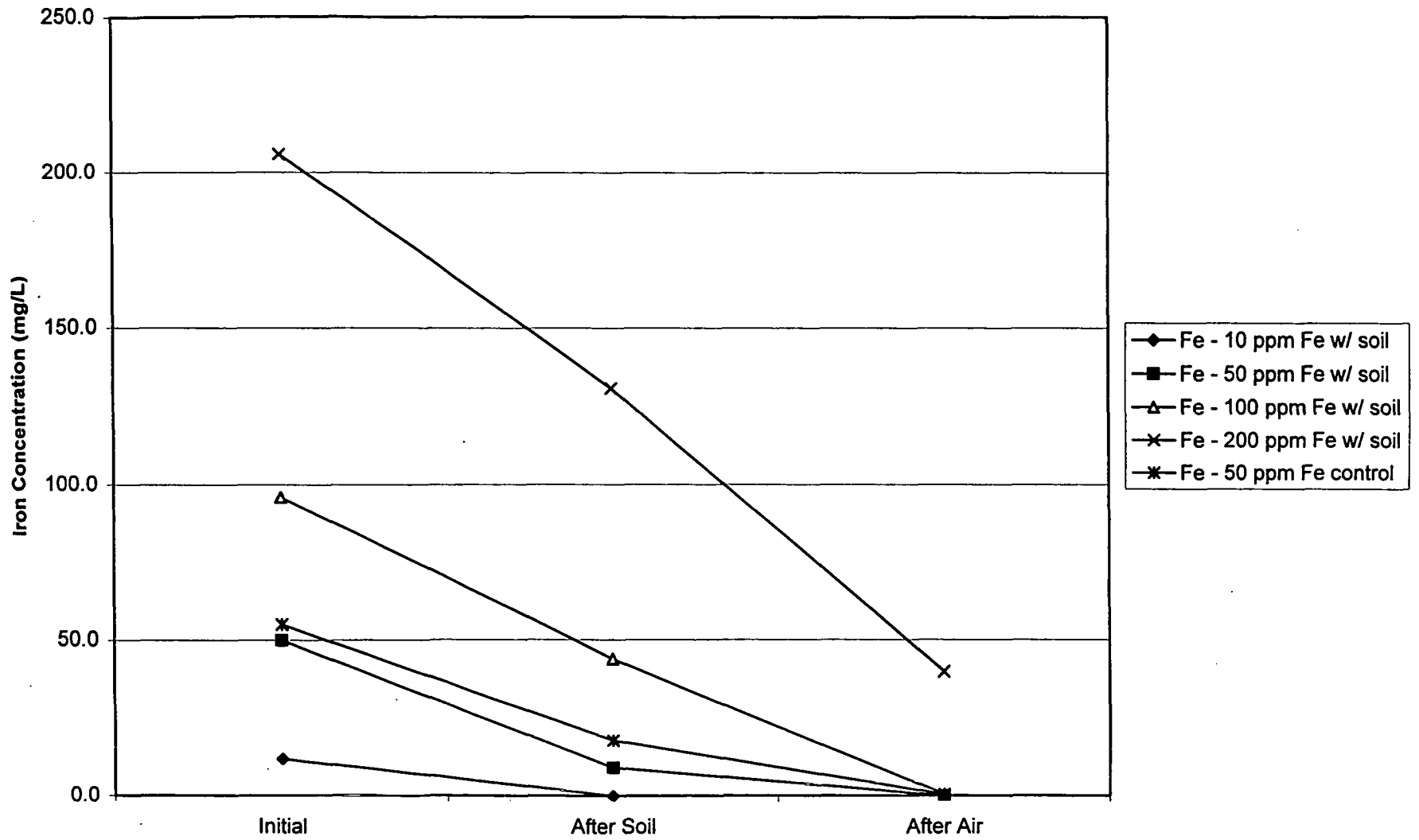


Figure 3A.2 - Test 3A Arsenic Results - Sample 2 (Sand)

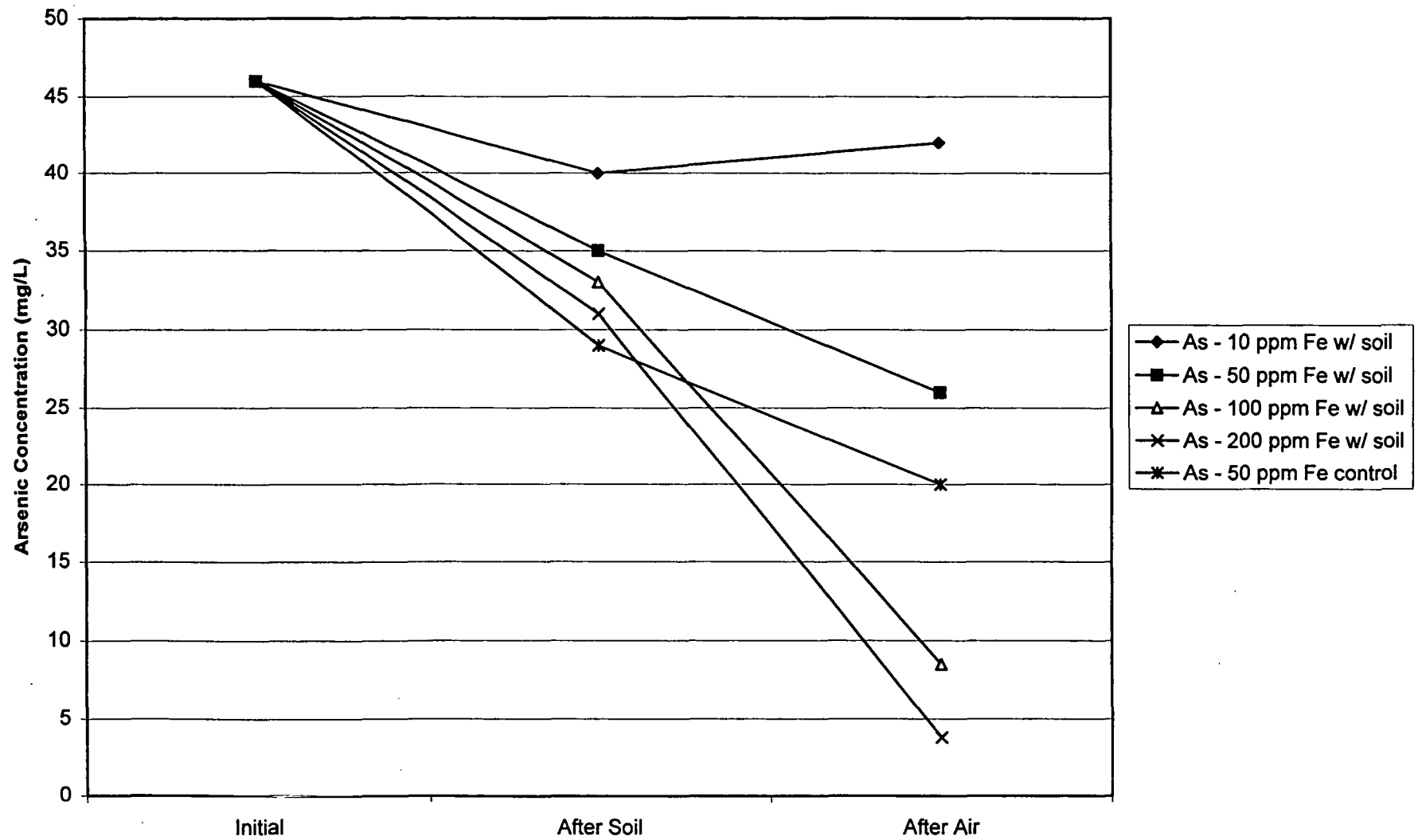


Figure 3A.1 - Test 3A Iron and Arsenic Results - Sample 2 (Sand)

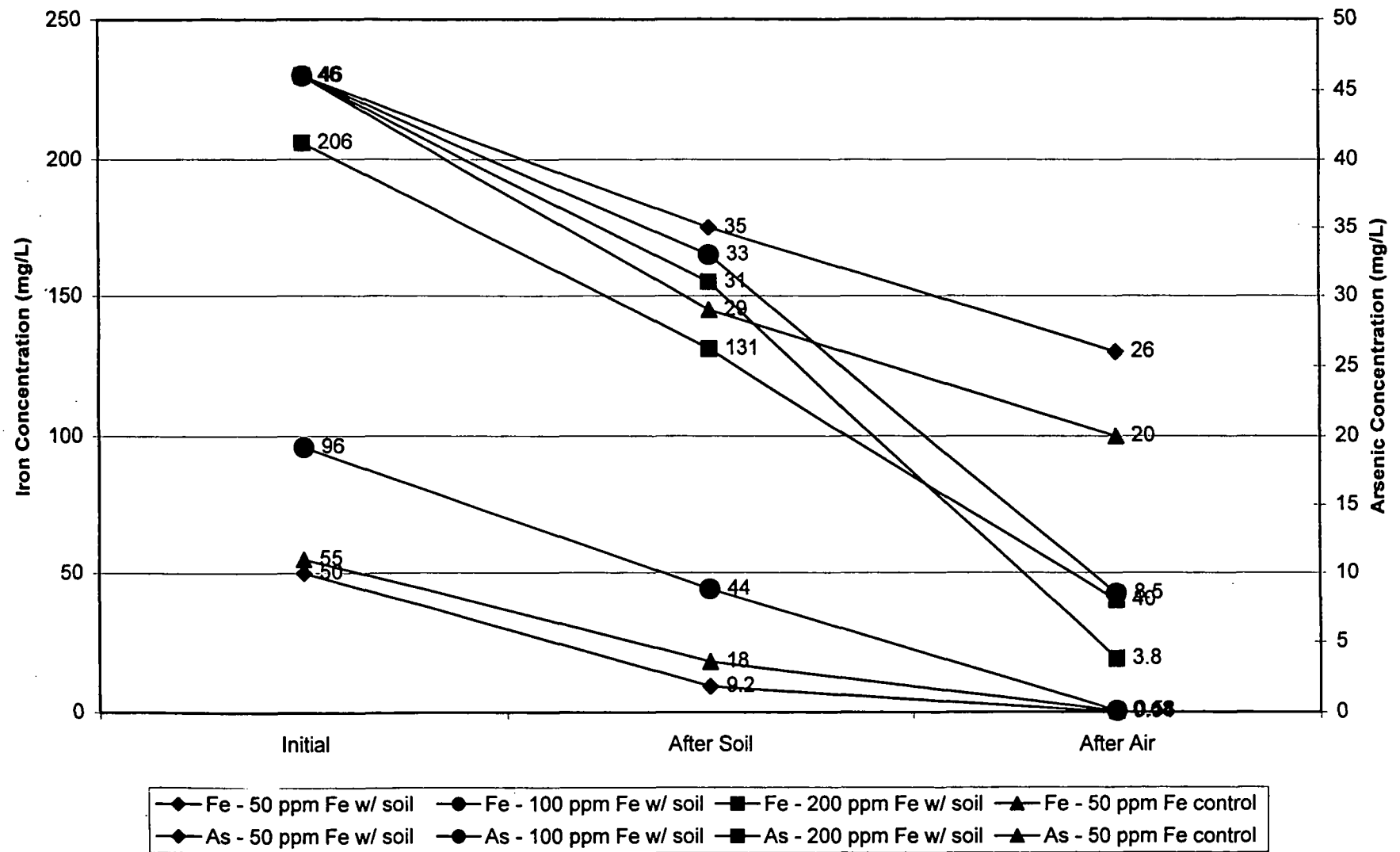


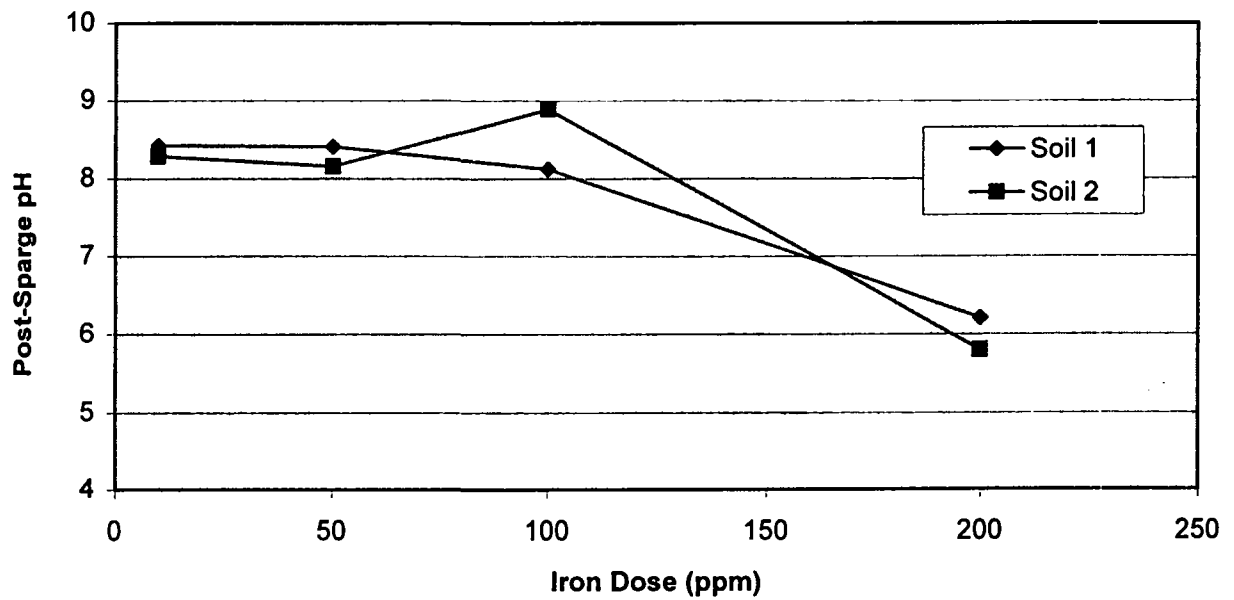
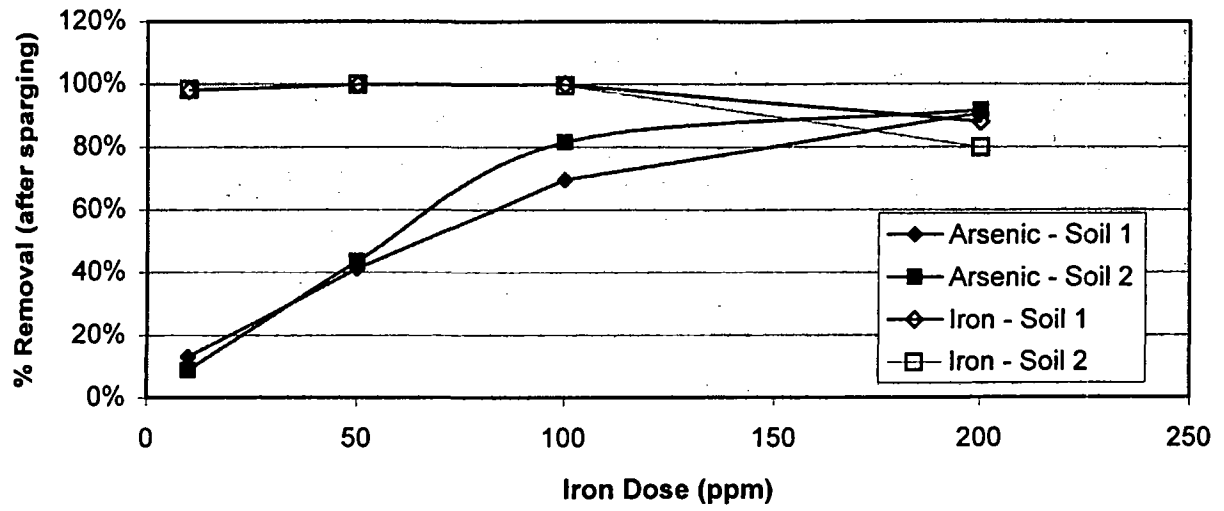
TABLE 3: IRON AND ARSENIC REMOVAL EFFICIENCIES

TESTS WITH SOIL 0004-126 (Sample 1, Silty Sand)									
Analysis of Initial Water Samples									
Sample	pH	SC	DO	Fe (Total)	Fe (+2)	% Fe(+2)			
10 ppm Fe w/ soil	6.93	2.91	2.17	10.2	6.8	67%			
50 ppm Fe w/ soil	7.01	2.99	1.03	49	33	67%			
100 ppm Fe w/ soil	6.99	3.06	1.04	100	74	74%			
200 ppm Fe w/ soil	6.84	3.22	0.96	212	149	70%			
50 ppm Fe control	7.01	2.96	1.03	56	43	77%			
Analysis After 24 hours of Soil Equalization									
							Lab		
Sample	pH	SC	DO	Fe (Total)	Fe (+2)	% Fe(+2)	Sample #	mg Fe Lost	% Fe Lost
10 ppm Fe w/ soil	7.26	2.85	1.46	0.33	0.17	52%	-101	6.909	97%
50 ppm Fe w/ soil	6.92	2.86	0.94	4.8	4.2	88%	-102	30.94	90%
100 ppm Fe w/ soil	6.69	2.94	0.90	29.5	14.5	49%	-103	49.35	71%
200 ppm Fe w/ soil	6.44	3.03	0.74	99	56.5	57%	-104	79.1	53%
50 ppm Fe control	6.90	2.86	0.85	24.5	20.5	84%	-105	22.05	56%
Analysis After 24 hours of Soil Equalization and 24 hours of "Sparging"									
							Lab		
Sample	pH	SC	DO	Fe (Total)	Fe (+2)	% Fe(+2)	Sample #	mg Fe Lost	% Fe Lost
10 ppm Fe w/ soil	8.43	3.09	3.54	0.2	0.0	0%	-106	7	98%
50 ppm Fe w/ soil	8.41	2.98	3.29	0.1	0.0	0%	-107	34.23	100%
100 ppm Fe w/ soil	8.12	3.07	3.31	0.2	0.1	50%	-108	69.86	100%
200 ppm Fe w/ soil	6.21	3.14	3.22	25.4	14.0	55%	-109	130.62	88%
50 ppm Fe control	8.38	2.99	3.30	0.2	0.1	50%	-110	39.06	100%
LAB RESULTS - IRON									
		After	After	pH	After	After			
Sample	Initial	Soil	Air	Initial	Soil	Air			
Fe - 10 ppm Fe w/ soil	10.2	0.11	0.11	6.93	7.26	8.43			
Fe - 50 ppm Fe w/ soil	49	2.2	0.033	7.01	6.92	8.41			
Fe - 100 ppm Fe w/ soil	100	15	0.15	6.99	6.69	8.12			
Fe - 200 ppm Fe w/ soil	212	84	25	6.84	6.44	6.21			
Fe - 50 ppm Fe control	56	23	0.12	7.01	6.90	8.38			
LAB RESULTS - Arsenic									
		After	After	% Removal	% Removal				
Sample	Initial	Soil	Air	(Soil)	(Sparge)				
As - 10 ppm Fe w/ soil	46	38	40	17%	13%				
As - 50 ppm Fe w/ soil	46	31	27	33%	41%				
As - 100 ppm Fe w/ soil	46	27	14	41%	70%				
As - 200 ppm Fe w/ soil	46	24	4.2	48%	91%				
As - 50 ppm Fe control	46	33	21	28%	54%				

TABLE 3(cont): IRON AND ARSENIC REMOVAL EFFICIENCIES

TESTS WITH SOIL 0004-128 (Sample 2, Sand)									
Analysis of Initial Water Samples									
Sample	pH	SC	DO	Fe (Total)	Fe (+2)	% Fe(+2)			
10 ppm Fe w/ soil	7.06	2.81	1.31	12.0	8.8	73%			
50 ppm Fe w/ soil	7.05	2.85	1.23	50	39	78%			
100 ppm Fe w/ soil	7.00	2.94	1.21	96	68	71%			
200 ppm Fe w/ soil	6.85	3.12	1.18	206	144	70%			
50 ppm Fe control	7.06	2.88	1.61	55	41	75%			
Analysis After 24 hours of Soil Equalization									
Sample	pH	SC	DO	Fe (Total)	Fe (+2)	% Fe(+2)	Lab		
							Sample #	mg Fe Lost	% Fe Lost
10 ppm Fe w/ soil	7.07	2.74	0.6	0.1	0.0	0%	-111	8.33	99%
50 ppm Fe w/ soil	6.82	2.80	0.47	9.5	7.4	78%	-112	28.35	81%
100 ppm Fe w/ soil	6.65	2.88	0.37	44.8	29.8	67%	-113	35.84	53%
200 ppm Fe w/ soil	6.51	3.02	0.42	140	97	69%	-114	46.2	32%
50 ppm Fe control	6.77	2.80	0.37	17.9	3.9	22%	-115	25.97	67%
Analysis After 24 hours of Soil Equalization and 24 hours of "Sparging"									
Sample	pH	SC*	DO	Fe (Total)	Fe (+2)	% Fe(+2)	Lab		
							Sample #	mg Fe Lost	% Fe Lost
10 ppm Fe w/ soil	8.29	3.20	3.05	0.2	0.1	50%	-116	8.26	98%
50 ppm Fe w/ soil	8.16	3.09	3.05	0.1	0.1	100%	-117	34.93	100%
100 ppm Fe w/ soil	8.89	3.16	3.04	0.5	0.1	20%	-118	66.85	99%
200 ppm Fe w/ soil	5.80	3.29	2.88	41.4	29.2	71%	-119	115.22	80%
50 ppm Fe control	7.83	3.19	2.83	0.5	0.3	60%	-120	38.15	99%
* SC Meter recalibrated morning before samples were analyzed - do not correlate with previous.									
LAB RESULTS - IRON									
Sample	Initial	After Soil	After Air	pH Initial	After Soil	After Air			
Fe - 10 ppm Fe w/ soil	12.0	0.03	0.083	7.06	7.07	8.29			
Fe - 50 ppm Fe w/ soil	50	9.2	0.04	7.05	6.82	8.16			
Fe - 100 ppm Fe w/ soil	96	44	0.58	7.00	6.65	8.89			
Fe - 200 ppm Fe w/ soil	206	131	40	6.85	6.51	5.80			
Fe - 50 ppm Fe control	55	18	0.48	7.06	6.77	7.83			
LAB RESULTS - Arsenic									
Sample	Initial	After Soil	After Air	% Removal (Soil)	% Removal (Sparge)				
As - 10 ppm Fe w/ soil	46	40	42	13%	9%				
As - 50 ppm Fe w/ soil	46	35	26	24%	43%				
As - 100 ppm Fe w/ soil	46	33	8.5	28%	82%				
As - 200 ppm Fe w/ soil	46	31	3.8	33%	92%				
As - 50 ppm Fe control	46	29	20	37%	57%				

Test 3A



IN PREPARATION FOR TEST 3, CHECK OXIDATION RATES OF WATERS

700 ppm Dose, soil #1

Placed Contents of Bottle 4 from Test 2 in Jar and Stirred Vigorously

Time (hrs)	pH	DO	Fe (T)	Fe (+2)	Observations
0	5.51	0.72			
0.08	5.55	1.85			
0.17	5.42	2.32			
2.25	4.01	3.1			
7.17	3.22	6.02	490	380	70%
24	3.32	6.54	555	410	79%
32	3.37	5.96	570	390	81%
48	3.41	6.13	625	380	89%
48	6.73				Added NaOH to increase pH, green ppt formed
49	5.97		320	270	46% Ppt is now orange and green

70 ppm Dose, soil #1

Placed Contents of Bottle 1 from Test 2 in Jar and Stirred Vigorously.

Time	pH	DO	Fe (T)	Fe (+2)	Observations
0	6.11	3.17			
8	7.78	6.55	5	1	
24	7.91	5.76	4	3	

70 ppm Dose, no soil

Placed Contents of Bottle 3 from Test 2 in Jar and Stirred Vigorously.

Time	pH	DO	Fe (T)	Fe (+2)	Observations
0	6.50	2.55	26	21	
16	8.08	6.06	0.5	0.5	Orange precipitate.

70 ppm Dose (no sodium hydrosulfite), no soil

Used previous reagent (1% Fe w/ City Water) and added 5 mL to 710 ml City Water.

Time	pH	DO	Fe (T)	Fe (+2)	Observations
0	6.13	3.69	37	30	Turned orange almost instantly.
16	4.61	6.14	11	9	Orange ppt.

Fe Dose	Initial Values		24-hr Soil Eq Values				24-hr Sparge Values			
	Fe	pH	As	Fe	pH	As	Fe	pH	As	
10 ppm	10.2	6.93	46	0.11	-0.9586073	7.26	38	0.11	8.43	40
50 ppm	49	7.01	46	2.2	0.34242268	6.92	31	0.033	8.41	27
100 ppm	100	6.99	46	15	1.17609126	6.69	27	0.15	8.12	14
200 ppm	212	6.84	46	84	1.92427929	6.44	24	25	6.21	4.2
10 ppm	12	7.06	46	0.03	-1.5228787	7.07	40	0.083	8.29	42
50 ppm	50	7.05	46	9.2	0.96378783	6.82	35	0.04	8.16	26
100 ppm	96	7.00	46	44	1.64345268	6.65	33	0.58	8.89	8.5
200 ppm	206	6.85	46	131	2.1172713	6.51	31	40	5.80	3.8
	73	7.12		13	1.11394335	6.54				
	740	6.64		30	1.47712125	6.62				
	2120	6.01		550	2.74036269	6.06				
	53	6.81		630	2.79934055	6.28				
	680	6.50		1960	3.29225607	5.62				
	2180	5.95		2060	3.31386722	5.83				
	53	6.25		30	1.47712125	5.99				
	690	5.93		24	1.38021124	6.04				
	2110	5.32		545	2.7363965	5.42				
	40	6.52		680	2.83250891	5.63				
	182	6.57		1990	3.29885308	4.92				
				2040	3.30963017	5.23				

Fe	pH				As			
	10 ppm	50 ppm	100 ppm	200 ppm	10 ppm	50 ppm	100 ppm	200 ppm
Initial	10.2	49	100	212	6.93	7.01	6.99	6.84
24-hr Soil	0.11	2.2	15	84	7.26	6.92	6.69	6.44
24-hr Sparge	0.11	0.033	0.15	25	8.43	8.41	8.12	6.21

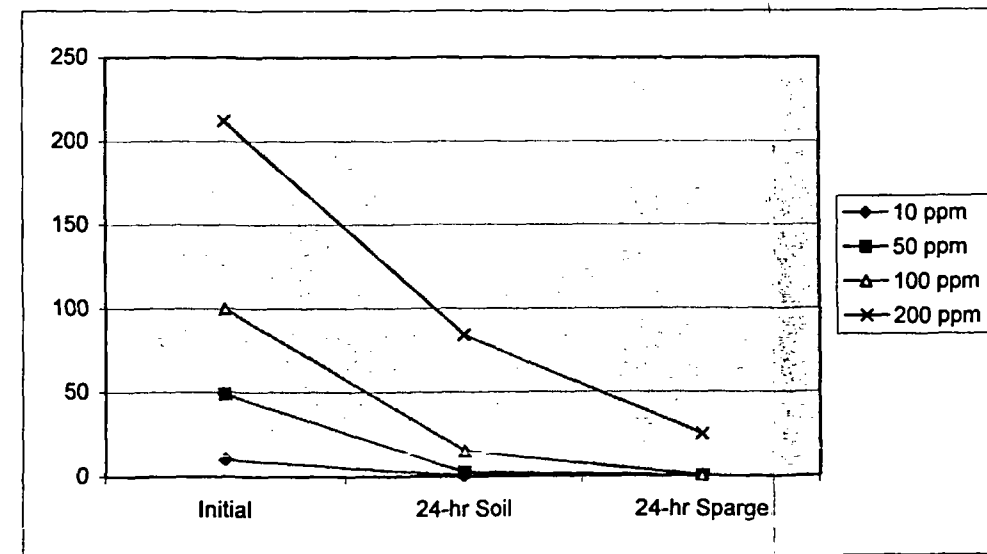
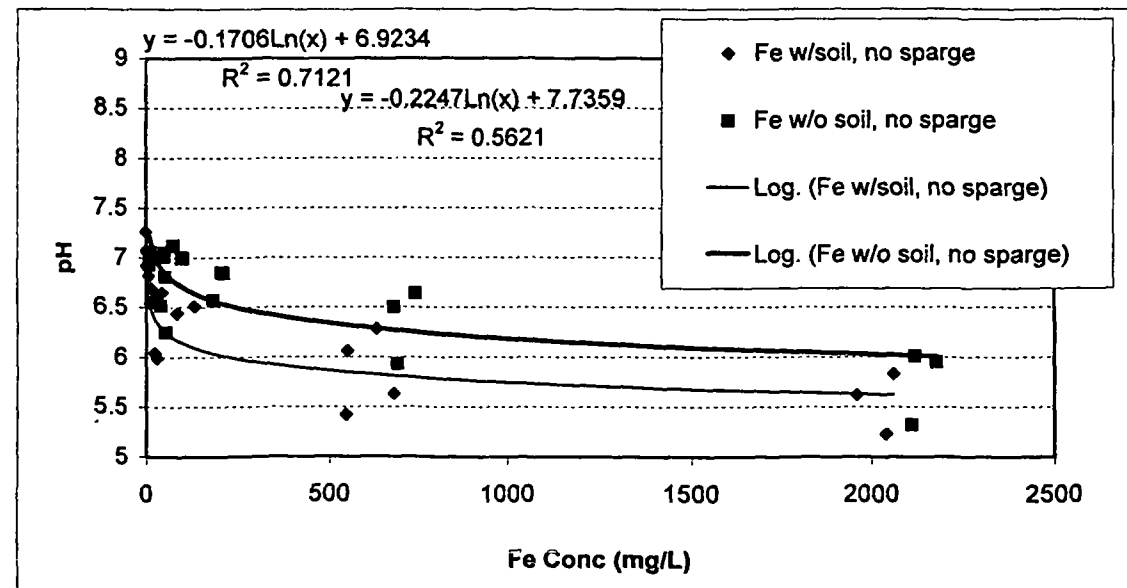


TABLE 2: ATTENUATION RATES FOR IRON IN NATIVE SampleS AT TEST SITE

Analysis of Initial Water Samples								
Sample	pH	SC	DO	Fe (Total)	Fe (+2)	% Fe(+2)		
Groundwater	7.17	2.90	0.53	0.73	0.45	62%		
70 ppm Fe	7.12	3.00	0.96	73	48	66%		
700 ppm Fe	6.64	4.06	0.18	740	445	60%		
2100 ppm Fe	6.01	6.13	0.13	2120	1300	61%		
1% Fe	2.72	15.83	0.12	10360	7120	69%		
Analysis of Soil/Groundwater Samples after 24 Hours							Mass Fe	% Fe
Sample	pH	SC	DO	Fe (Total)	Fe (+2)	% Fe(+2)	Lost (mg)	Lost (mg)
70 ppm Fe/Sample #1	6.54	2.97	0.52	13	12	92%	28	75%
70 ppm Fe/Sample #2	6.62	3.03	0.33	30	26	87%	16.1	43%
70 ppm Fe	6.81	3.08	0.29	53	47	89%		
700 ppm Fe/Sample #1	6.06	4.14	0.26	550	430	78%	91	19%
700 ppm Fe/Sample #2	6.28	4.16	0.26	630	462	73%	35	7%
700 ppm Fe	6.50	4.16	0.17	680	475	70%		
2100 ppm Fe/Sample #1	5.62	6.23	0.29	1960	1470	75%	154	10%
2100 ppm Fe/Sample #2	5.83	6.24	0.41	2060	1260	61%	84	6%
2100 ppm Fe	5.95	6.23	0.18	2180	1260	58%		
Groundwater/Sample #1	7.03	3.06	0.14	4.33	3.33	77%		
Analysis of Soil/Groundwater Samples after 60 Hours							Mass Fe	% Fe
Sample	pH	SC	DO	Fe (Total)	Fe (+2)	% Fe(+2)	Lost (mg)	Lost (mg)
70 ppm Fe/Sample #1	5.99	3.05	0.48	30	6	20%	16.1	43%
70 ppm Fe/Sample #2	6.04	2.93	0.56	24	22	92%	20.3	55%
70 ppm Fe	6.25	3.05	0.28	53	42	79%		
700 ppm Fe/Sample #1	5.42	4.08	0.43	545	310	57%	101.5	21%
700 ppm Fe/Sample #2	5.63	4.06	0.35	680	315	46%	7	1%
700 ppm Fe	5.93	4.13	0.20	690	350	51%		
2100 ppm Fe/Sample #1	4.92	6.18	0.31	1990	1140	57%	84	6%
2100 ppm Fe/Sample #2	5.23	6.14	0.32	2040	1320	65%	49	3%
2100 ppm Fe	5.32	6.20	0.18	2110	1040	49%		
Groundwater/Sample #1	6.54	2.96	0.40	0.60	0.00	0%		

TEST 2 RESULTS

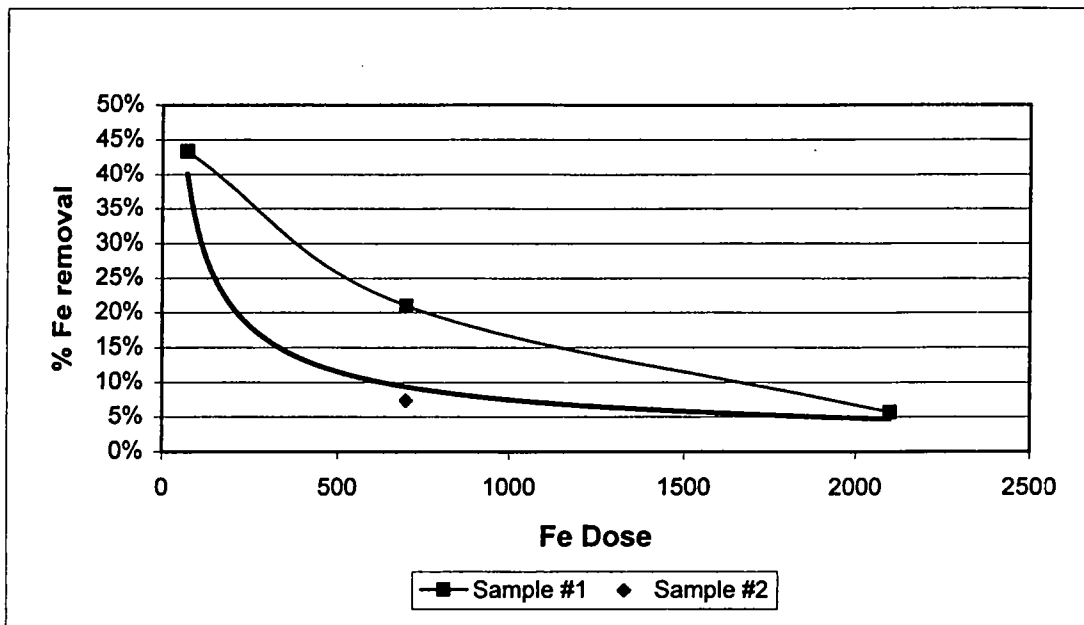


FIGURE 2.1: PERCENT IRON REMOVAL VS. IRON DOSE

Note: reagent mixed with soil prior to sparging

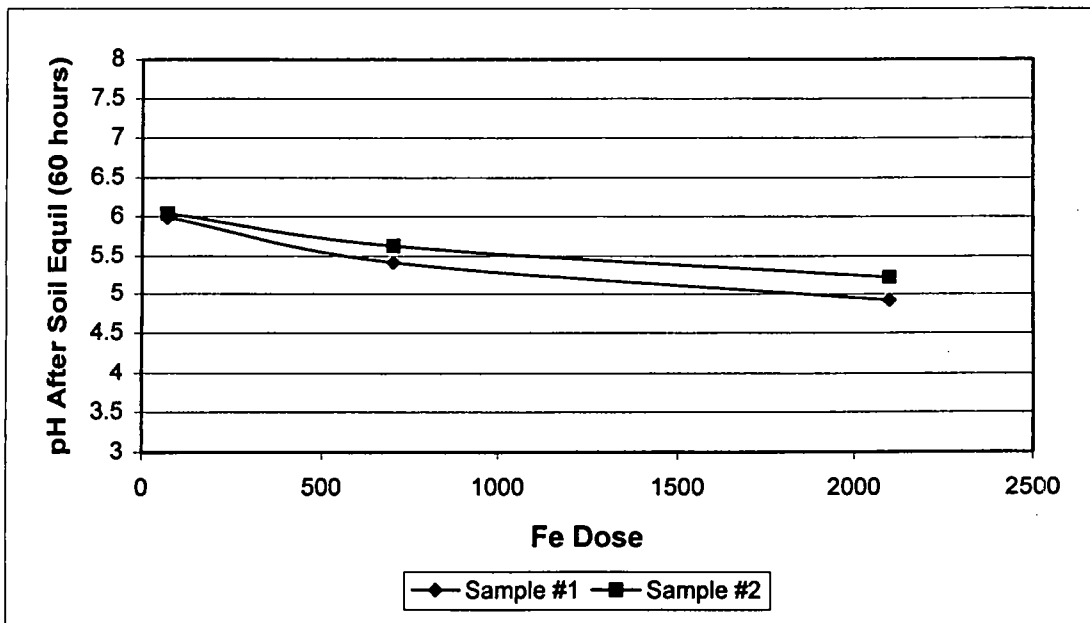


FIGURE 2.2: EQUILIBRATED pH VS. IRON DOSE

TABLE 1A: IRON SOLUBILITY IN AMBIENT GROUNDWATER

Sample	pH	SC	DO	Fe (Total)	Fe (+2)	% Fe(+2)	Observations:
@ 16 Hours:							
Control	7.16	2.86	2.60	0.22	0.12	55%	
70 ppm Fe	6.87	2.99	1.25	55	47	85%	Visible orange solids - settled
700 ppm Fe	6.39	3.95	1.05	830	700	84%	Visible orange solids - settled
2100 ppm Fe	5.39	5.70	1.35	2100	1990	95%	Visible orange solids - settled
10,000 ppm Fe	2.73	14.24	4.39	9600	8200	85%	Orange green color - clear
@ 4 Days:							
Control	7.21	2.81	2.57	3.22	0.29	9%	
70 ppm Fe	6.84	2.92	0.96	53	41	77%	Visible orange solids - settled
700 ppm Fe	6.41	3.93	0.92	685	640	93%	Visible orange solids - settled
2100 ppm Fe	5.17	5.71	1.09	1980	1950	98%	Visible orange solids - settled
10,000 ppm Fe				9900	8700	88%	Orange green color - clear
@ 7 Days:							
	(could not keep air out)						
Control	7.56	2.91	5.55	0.49	0.09	18%	
70 ppm Fe	6.93	2.96	2.62	50	45	90%	Visible orange solids - settled
700 ppm Fe	6.21	3.90	1.52	880	850	97%	Visible orange solids - settled
2100 ppm Fe	5.04	5.70	2.95	2070	1350	65%	Visible orange solids - settled
10,000 ppm Fe				9480	5600	59%	Orange green color - clear

TABLE 1B: IRON PRECIPITATION WITH PRESENCE OF DISSOLVED OXYGEN IN GROUNDWATER

Sample	pH	SC	DO	Fe (Total)	Fe (+2)	% Fe(+2)	Observations:
Control	6.39	3.95	1.05	830	700	84%	Visible orange solids - settled
w/ 5ml 1% Na ₂ S ₂ O ₄	6.41	3.97	0.55	720	640	89%	Visible orange solids - settled

TABLE 1C: OXIDATION OF REAGENT WITH PRESENCE OF DISSOLVED OXYGEN IN SOLVENT (DI)

Sample	pH	SC	DO	Fe (Total)	Fe (+2)	% Fe(+2)	Observations:
Control	2.73	14.24	4.39	9600	8200	85%	Orange green color - clear
w/ 15ml 1% Na ₂ S ₂ O ₄	2.33		0.18	10,160	7160	70%	Orange green color - clear

TABLE 1D: FERRIC REDUCTION TO FERROUS

Sample	pH	SC	DO	Fe (Total)	Fe (+2)	% Fe(+2)	Observations:
1% Fe w/DI water				9480	5600	59%	Orange green color - clear
- w/20ml 1% NH ₂ OH	2.55	14.14	5.11	10,240	6760	66%	Orange green color - clear
1%Fe w/ EH City wtr	2.52	14.64	5.08	11,240	6960	62%	Cloudy yellow green - settled orange ppt.
- w/50ml 1% NH ₂ OH	2.46		3.91	10,120	7080	70%	Cloudy yellow green - settled orange ppt.
- w/ 2g Na ₂ S ₂ O ₄				10,600	8320	78%	Light green blue color - clear
- w/ 3g Na ₂ S ₂ O ₄				11,360	8520	75%	Light green blue color - clear
1% Fe w/deo.DI water	2.33		0.18	10,160	7160	70%	Orange green color - clear
- w/ 2g Na ₂ S ₂ O ₄	2.70			11000	8650	79%	Light green blue color - clear
- same next day				9600	5680	59%	Small amount of orange ppt.

TABLE 1E: EFFECTS OF REDUCING REAGENT ON PRECIPITATION IN GROUNDWATER

Sample	pH	SC	DO	Fe (Total)	Fe (+2)	% Fe(+2)	Observations:
Sample w/out Reagent	6.39	3.95	1.05	830	700	84%	Visible orange solids - settled
Reagent				9600	5680	59%	Small amount of orange ppt.
Sample w/ Reagent				715	415	58%	Small amount of orange & white ppt.

TABLE 1F: EFFECTS OF SOLVENT ON REAGENT SOLUTION QUALITY

Sample	pH	SC	DO	Fe (Total)	Fe (+2)	% Fe(+2)	Observations:
DI water	2.73	14.24	4.39	9600	8200	85%	Orange green color - clear
East Helena City water	2.52	14.64	5.08	11,240	6960	62%	Cloudy yellow green - settled orange ppt.
Upper Lake water	2.51		4.39	15,200	11,800	78%	Cloudy yellow green - settled orange ppt.

TABLE 1G: EFFECTS OF REAGENT ON SOLUTION WATER QUALITY

Sample	pH	SC	DO	Fe (Total)	Fe (+2)	% Fe(+2)	Observations:
Ferrous Sulfate	2.52	14.64	5.08	11,240	6,960	62%	Cloudy yellow green - settled orange ppt.
Citric Acid Complex	1.32	19.85	0.79	9,960	2,360	24%	Dark orange-green solution-orange ppt.
Ferrous Sulfate/REAX	2.91	14.75	3.38	11,120	6,800	61%	Very black soln - not much ppt.

TEST 1: VERIFY THAT IRON IS SOLUBLE IN AMBIENT GROUNDWATER

1A OBJECTIVE: Determine whether the reagent is stable in groundwater over time.

Procedure: Mixed up 1% solution of ferrous sulfate. Added 3 different doses of iron reagent to groundwater samples, sealed in air-tight containers, and monitored iron concentrations over time.

Sample	pH	SC	DO	Fe (Total)	Fe (+2)	% Fe(+2)	Observations:
@ 16 Hours:							
Control	7.16	2.86	2.60	0.22	0.12	55%	
70 ppm Fe	6.87	2.99	1.25	55	47	85%	Visible orange solids - settled
700 ppm Fe	6.39	3.95	1.05	830	700	84%	Visible orange solids - settled
2100 ppm Fe	5.39	5.70	1.35	2100	1990	95%	Visible orange solids - settled
10,000 ppm Fe	2.73	14.24	4.39	9600	8200	85%	Orange green color - clear
@ 4 Days:							
Control	7.21	2.81	2.57	3.22	0.29	9%	
70 ppm Fe	6.84	2.92	0.96	53	41	77%	Visible orange solids - settled
700 ppm Fe	6.41	3.93	0.92	685	640	93%	Visible orange solids - settled
2100 ppm Fe	5.17	5.71	1.09	1980	1950	98%	Visible orange solids - settled
10,000 ppm Fe				9900	8700	88%	Orange green color - clear
@ 7 Days: (could not keep air out)							
Control	7.56	2.91	5.55	0.49	0.09	18%	
70 ppm Fe	6.93	2.96	2.62	50	45	90%	Visible orange solids - settled
700 ppm Fe	6.21	3.90	1.52	880	850	97%	Visible orange solids - settled
2100 ppm Fe	5.04	5.70	2.95	2070	1350	65%	Visible orange solids - settled
10,000 ppm Fe				9480	5600	59%	Orange green color - clear

Conclusions: Dissolved iron concentrations appear stable over time. The ferrous iron ratio may be more unstable at higher ratios. The amount of solids precipitated with the addition of reagent is significant, but does not appear to be a function of the quantity of iron introduced.

1B OBJECTIVE: Determine whether the precipitate formed is due to the presence of dissolved oxygen in the groundwater.

Procedure: Made 1% soln of sodium hydrosulfite. Added enough to reduce oxygen in groundwater below 1 ppm and then added 700 ppm dose of iron (using 1% ferrous sulfate solution).

Sample	pH	SC	DO	Fe (Total)	Fe (+2)	% Fe(+2)	Observations:
Control	6.39	3.95	1.05	830	700	84%	Visible orange solids - settled
w/ 5ml 1% Na ₂ S ₂ O ₄	6.41	3.97	0.55	720	640	89%	Visible orange solids - settled

Conclusions: Dissolved oxygen in the groundwater does not appear to be a major factor in precipitation.

1C OBJECTIVE: Determine whether oxidation of reagent is due to presence of dissolved oxygen in solvent (DI).

Procedure: Took a 710 mL sample of DI and added enough of 1% sodium hydrosulfite solution to reduce oxygen below 1 ppm. Added 35.5 g of ferrous sulfate to make a 1% iron solution.

Sample	pH	SC	DO	Fe (Total)	Fe (+2)	% Fe(+2)	Observations:
Control	2.73	14.24	4.39	9600	8200	85%	Orange green color - clear
w/ 15ml 1% Na ₂ S ₂ O ₄	2.33		0.18	10,160	7160	70%	Orange green color - clear

Conclusions: Dissolved oxygen in DI does not appear to be a major factor in reagent oxidation.

1D OBJECTIVE: Determine if ferric can be reduced to ferrous in samples and increase ferrous ratios.

Procedure: Add hydroxyl amine and sodium hydrosulfite (reducing agents) to different reagent samples and compare iron results.

Sample	pH	SC	DO	Fe (Total)	Fe (+2)	% Fe(+2)	Observations:
1% Fe w/DI water				9480	5600	59%	Orange green color - clear
- w/20ml 1% NH ₂ OH	2.55	14.14	5.11	10,240	6760	66%	Orange green color - clear
1%Fe w/ EH City wtr	2.52	14.64	5.08	11,240	6960	62%	Cloudy yellow green - settled orange ppt.
- w/50ml 1% NH ₂ OH	2.46		3.91	10,120	7080	70%	Cloudy yellow green - settled orange ppt.
- w/ 2g Na ₂ S ₂ O ₄				10,600	8320	78%	Light green blue color - clear
- w/ 3g Na ₂ S ₂ O ₄				11,360	8520	75%	Light green blue color - clear
1% Fe w/deo.DI water	2.33		0.18	10,160	7160	70%	Orange green color - clear
- w/ 2g Na ₂ S ₂ O ₄	2.70			11000	8650	79%	Light green blue color - clear
- same next day				9600	5680	59%	Small amount of orange ppt.

Conclusions: Adding reducing agents to groundwater does not appear to greatly improve the ferrous ratio. However, the addition of reducing agents does appear to reduce the solids precipitated in the reagent solution. It would also appear that although the analyses do not show a decrease in the ferric concentrations, observation indicates that ferric concentrations are in fact decreasing. This could be masked in the analyses due to interference in the colormetric method or complexing/chelating reaction of some sort.

1E OBJECTIVE: Determine if the addition of a reduced iron solution (above) can decrease precipitation in groundwater.

Procedure: Used 1% Fe solution w/ 2 g of sodium sulfite to add 700 ppm dose of reagent to groundwater sample.

Sample	pH	SC	DO	Fe (Total)	Fe (+2)	% Fe(+2)	Observations:
Sample w/out Reagent	6.39	3.95	1.05	830	700	84%	Visible orange solids - settled
Reagent				9600	5680	59%	Small amount of orange ppt.
Sample w/ Reagent				715	415	58%	Small amount of orange & white ppt.

Conclusions: Adding reduced reagent solution to groundwater greatly reduces the amount of solids precipitated by groundwater.

1F OBJECTIVE: Determine if the quality of reagent solution significantly changes with solvent used.

Procedure: Make 1% Fe solution using DI, East Helena City water and Upper Lake water.

Sample	pH	SC	DO	Fe (Total)	Fe (+2)	% Fe(+2)	Observations:
DI water	2.73	14.24	4.39	9600	8200	85%	Orange green color - clear
East Helena City water	2.52	14.64	5.08	11,240	6960	62%	Cloudy yellow green - settled orange ppt.
Upper Lake water	2.51		4.39	15,200	11,800	78%	Cloudy yellow green - settled orange ppt.

Conclusions: East Helena City water appears to result in higher SC and DO and lower ferrous iron.

1G OBJECTIVE: Determine if the reagent used significantly changes reagent solution water quality.

Procedure: Make 1% Fe solution using Citric Acid Complex and using REAX as complexing agent and City Water.

Sample	pH	SC	DO	Fe (Total)	Fe (+2)	% Fe(+2)	Observations:
Ferrous Sulfate	2.52	14.64	5.08	11,240	6,960	62%	Cloudy yellow green - settled orange ppt.
Citric Acid Complex	1.32	19.85	0.79	9,960	2,360	24%	Dark orange-green solution-orange ppt.
Ferrous Sulfate/REAX	2.91	14.75	3.38	11,120	6,800	61%	Very black soln - not much ppt.

Conclusions: CAC has lower percent ferrous and much lower pH. REAX reagent makes water very black but otherwise appears comparable to ferrous sulfate.

Ferrous Reagent

Bottle Volume	1000 mL
Reagent Weight	50 g as $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$
Dose	10000 mg/L as Fe
pH	2.73
DO	4.39 mg/L
SC	14.24 mS/cm
Ferrous Iron	8700 mg/L
Total Iron	9900 mg/L
Ferric Iron	1200 mg/L
Ferrous/Ferric Ratio	7.3

2100 ppm Dose Fe

Temperature	8.5 deg C
Bottle Volume	710 mL
Reagent Conc.	10000 mg/L as Fe
Reagent Volume	150 mL
Dose	2113 mg/L as Fe

After 16 hours:

pH	5.39
DO	1.35 mg/L
SC	5.70 mS/cm
Ferrous Iron	1990 mg/L
Total Iron	2100 mg/L
Alkalinity	0 mg/L as CaCO_3

Mass of Iron Ppt.	9 mg
Ferric Iron	110 mg/L
Ferrous/Ferric Ratio	18.1

After 4 days:

pH	5.17
DO	1.09 mg/L
SC	5.71 mS/cm
Ferrous Iron	1950 mg/L
Total Iron	1980 mg/L
Alkalinity	mg/L as CaCO_3

Mass of Iron Ppt.	94.2 mg
Ferric Iron	30 mg/L
Ferrous/Ferric Ratio	65.0

700 ppm Dose Fe

Temperature	8.5 deg C
Bottle Volume	710 mL
Reagent Conc.	10000 mg/L as Fe
Reagent Volume	50 mL
Dose	704 mg/L as Fe

After 16 hours:

pH	6.39
DO	1.05 mg/L
SC	3.95 mS/cm
Ferrous Iron	700 mg/L
Total Iron	830 mg/L
Alkalinity	120 mg/L as CaCO_3

Mass of Iron Ppt.	-89.3 mg
Ferric Iron	130 mg/L

After 4 days:

pH	6.41
DO	0.92 mg/L
SC	3.93 mS/cm
Ferrous Iron	640 mg/L
Total Iron	685 mg/L
Alkalinity	mg/L as CaCO_3

Mass of Iron Ppt.	13.65 mg
Ferric Iron	45 mg/L

Ferrous/Ferric Ratio 5.4

Ferrous/Ferric Ratio 14.2

700 ppm Dose Fe with Sodium Hydrosulfite

Temperature 8.5 deg C
Bottle Volume 710 mL
Reagent Conc. 10000 mg/L as Fe
Reagent Volume 50 mL
Dose 704 mg/L as Fe

After 24 hours:

pH 6.41
DO 0.55 mg/L
SC 3.97 mS/cm
Ferrous Iron 640 mg/L
Total Iron 720 mg/L

Mass of Iron Ppt. -11.2 mg
Ferric Iron 80 mg/L
Ferrous/Ferric Ratio 8.0

70 ppm Dose Fe

Temperature 8.5 deg C
Bottle Volume 710 mL
Reagent Conc. 10000 mg/L as Fe
Reagent Volume 5 mL
Dose 70.4 mg/L as Fe

After 16 hours:

pH 6.87
DO 1.25 mg/L
SC 2.99 mS/cm
Ferrous Iron 47 mg/L
Total Iron 55 mg/L
Alkalinity 180 mg/L as CaCO₃

Mass of Iron Ppt. 10.95 mg
Ferric Iron 8 mg/L
Ferrous/Ferric Ratio 5.9

After 4 days:

pH 6.84
DO 0.96 mg/L
SC 2.92 mS/cm
Ferrous Iron 41 mg/L
Total Iron 53 mg/L
Alkalinity mg/L as CaCO₃

Mass of Iron Ppt. 12.37 mg
Ferric Iron 12 mg/L
Ferrous/Ferric Ratio 3.4

ATTACHMENT 3

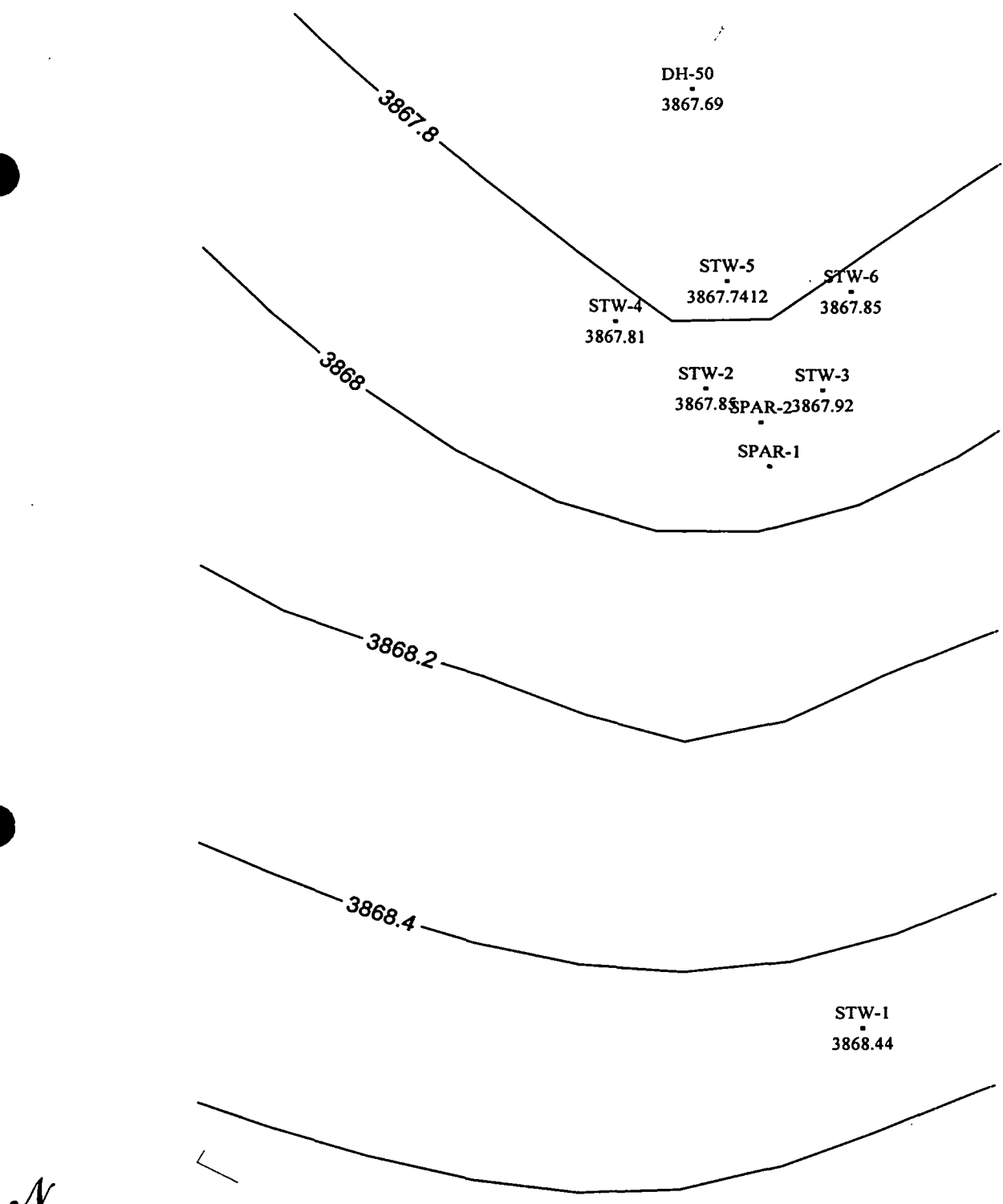
➤ TABLE 2 – PILOT-SCALE PHASE III SPARGE TESTING PRELIMINARY SAMPLING SCHEDULE

Pilot-Scale Phase III Sparge Testing Preliminary Sampling Schedule

Sampling Schedule													
		Well Number											
Sampling Round	Week of	STW-1	STW-2	STW-3	STW-4	STW-5	STW-6	STW-7	STW-8	STW-9	DH-50	SPAR-3	DH-24
1	24-Sep-01	F,C,A,M	F,C,A,M	F,C,A,M	F,C,A,M	F,C,A,M	F,C,A,M	F,C,A,M	F,C,A,M	F,C,A,M	F,C,A,M	F,C,A,M	F,C,A,M
2	8-Oct-01		F	F	F	F	F	F	F	F	F	F	F
3*	22-Oct-01		F,C,A	F,C,A	F,C,A	F,C,A	F,C,A	F,C,A	F,C,A	F,C,A	F,C,A	F,C,A	F,C,A
4	29-Oct-01		F	F					F			F	F
5	5-Nov-01		F	F					F			F	F
6	12-Nov-01		F	F					F			F	F
7	19-Nov-01		F,C,A	F,C,A					F,C,A			F,C,A	F,C,A
8	26-Nov-01		F	F	F		F		F	F		F	F
9	3-Dec-01		F	F	F		F		F	F		F	F
10	10-Dec-01		F	F	F		F		F	F		F	F
11	17-Dec-01		F,C,A	F,C,A	F,C,A		F,C,A		F,C,A	F,C,A		F,C,A	F,C,A
12	24-Dec-01		F	F	F	F	F		F	F	F	F	F
13	31-Dec-01		F	F	F	F	F		F	F	F	F	F
14	7-Jan-02		F	F	F	F	F		F	F	F	F	F
15	14-Jan-02	F,C,A,M	F,C,A,M	F,C,A,M	F,C,A,M	F,C,A,M	F,C,A,M	F,C,A,M	F,C,A,M	F,C,A,M	F,C,A,M	F,C,A,M	F,C,A,M
* Fe dosing will begin following Sampling Round 3													
Parameter Suites			Sampling Bottles/Preservatives										
Parameter	Lab Method	Project Detection Limit Goal (mg/L)											
Field Parameters (F)			Parameter Suite Bottles Preservative										
pH	field	na	F na na										
specific conductance	field	na	C 1-1000 mL UF/Raw										
dissolved oxygen	field	na	A 1-250 mL F/HCl										
temperature	field	na	I 1-250 mL F/HNO3										
Eh	field	na	M 1-500 mL F/HNO3										
Fe+2/Fe+3	field	na											
static water level	field	na											
Common Constituents (C)													
sulfate (SO4)	9036	1											
total alkalinity as CaCO3	310.1	1											
Arsenic/Arsenic Speciation (A)													
As (diss)	7060/6010A/6020	0.005											
As3+	7060/6010A/6020	0.02											
As5+	7060/6010A/6020	0.02											
Metals (M)													
Cd (diss)	7131/7130/6010A/6020	0.001											
Fe (diss)	6010A	0.02											
Mn (diss)	6010A	0.015											
Pb (diss)	7421/7420/6010A/6020	0.005											
Zn (diss)	7950/6010A/6020	0.02											

APPENDIX E

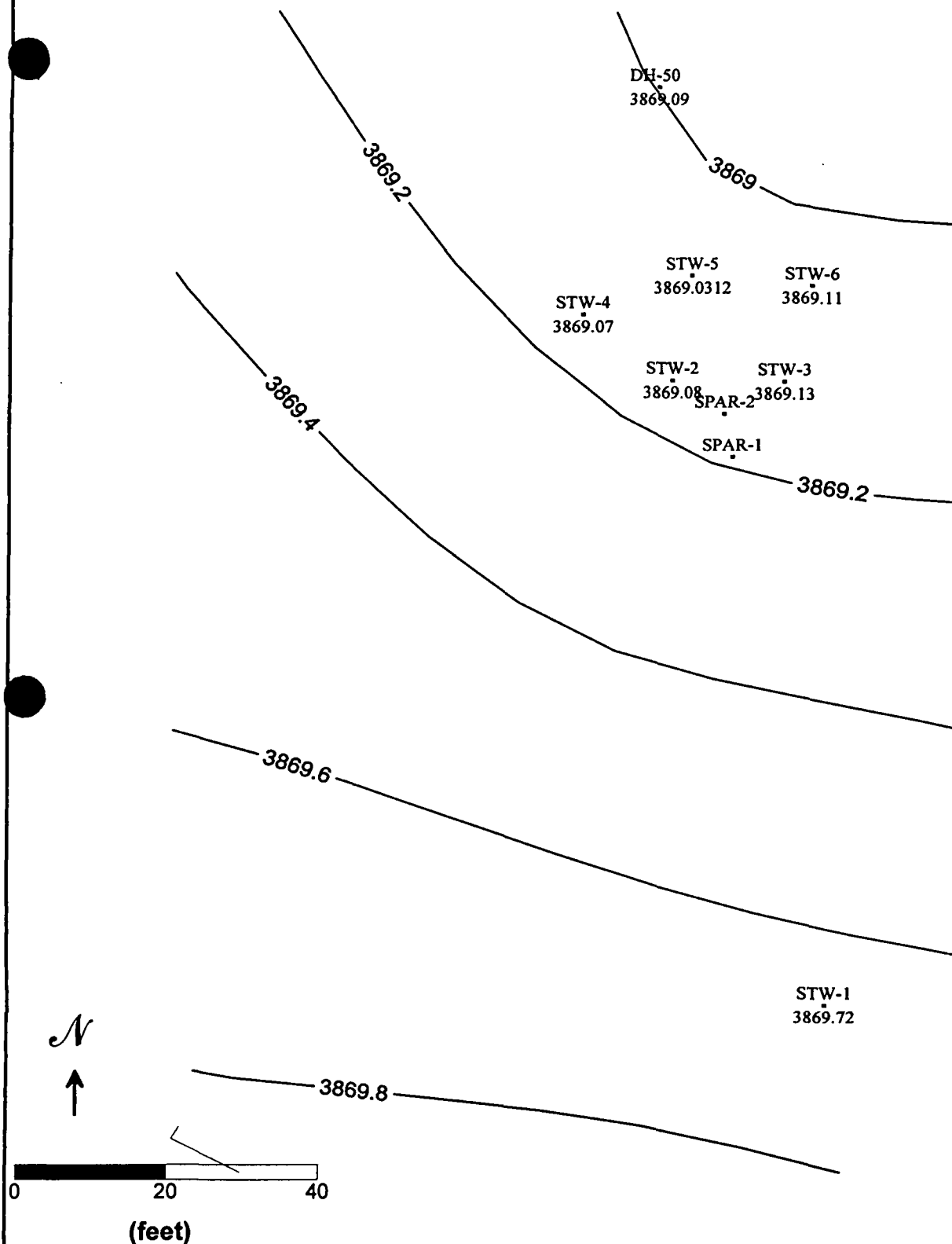
POTENTIOMETRIC SURFACE MAPS FOR THE SPARGE PILOT TEST AREA



INTERIM MEASURES
AIR SPARGING
PILOT TEST REPORT

May 10, 2000
POTENTIOMETRIC SURFACE MAP
Before Sparge Startup (5/23/00)

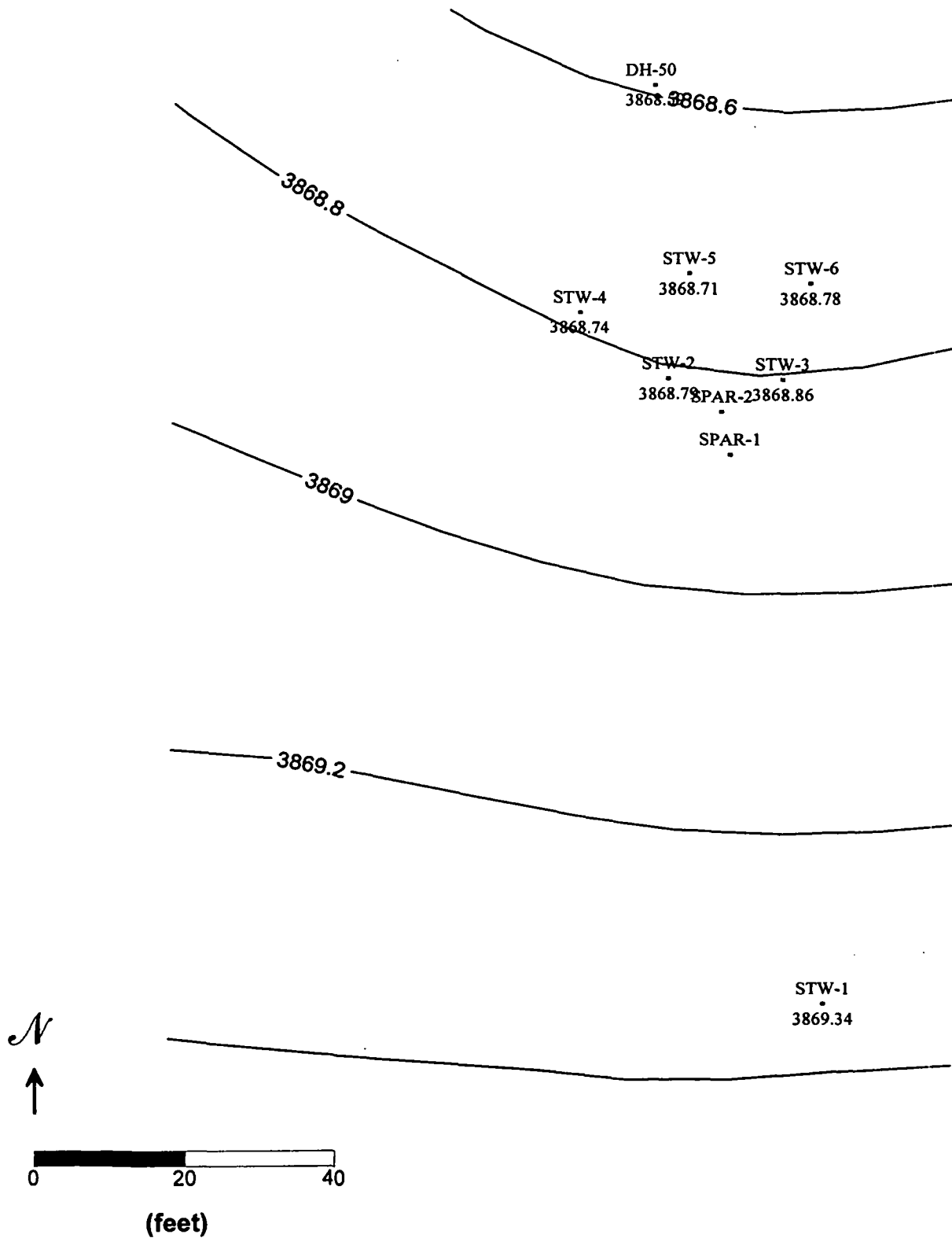
FIGURE



INTERIM MEASURES
AIR SPARGING
PILOT TEST REPORT

AUGUST 3, 2000
POTENTIOMETRIC SURFACE MAP

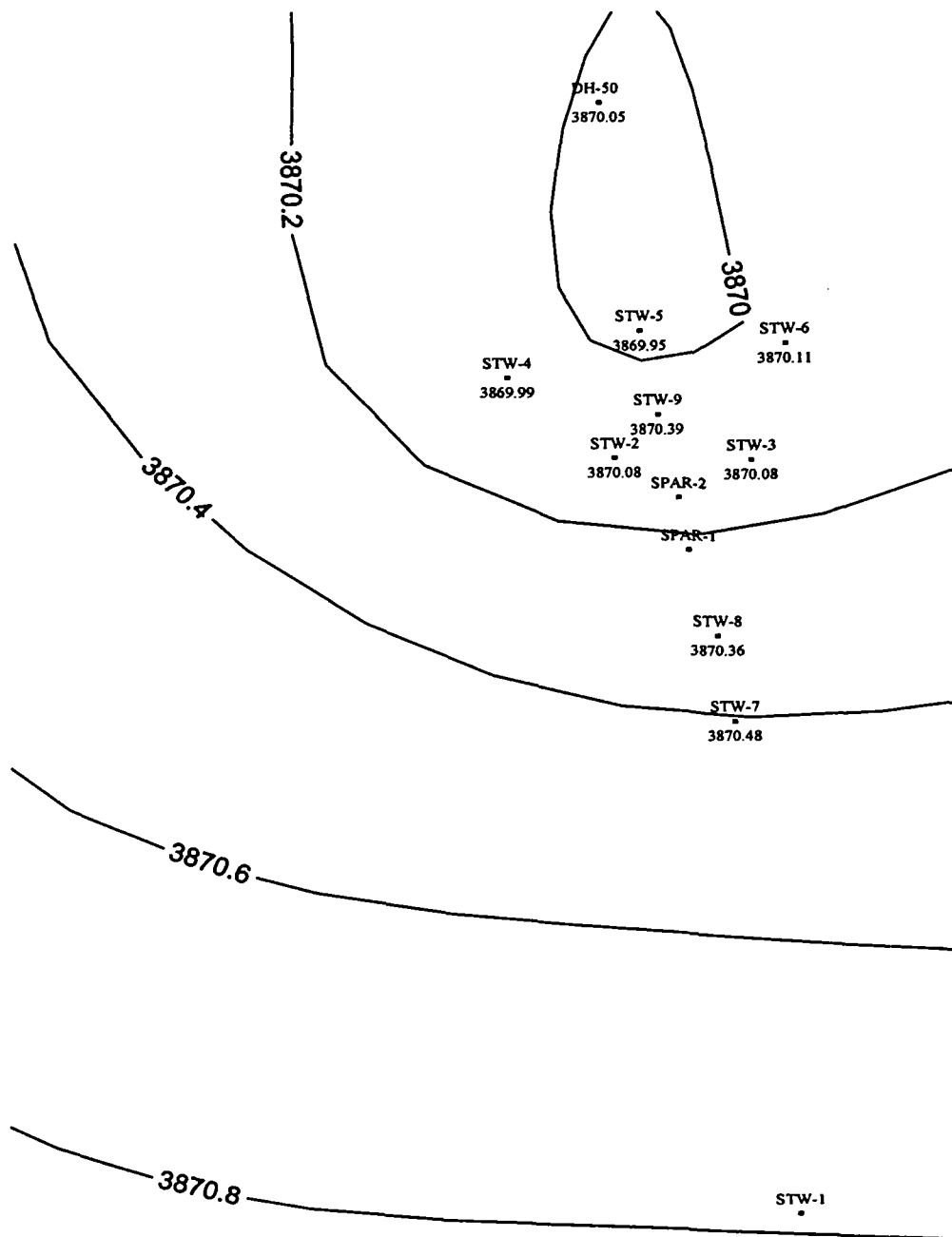
FIGURE



INTERIM MEASURES
AIR SPARGING
PILOT TEST REPORT

AUGUST 31, 2000
POTENTIOMETRIC SURFACE MAP

FIGURE



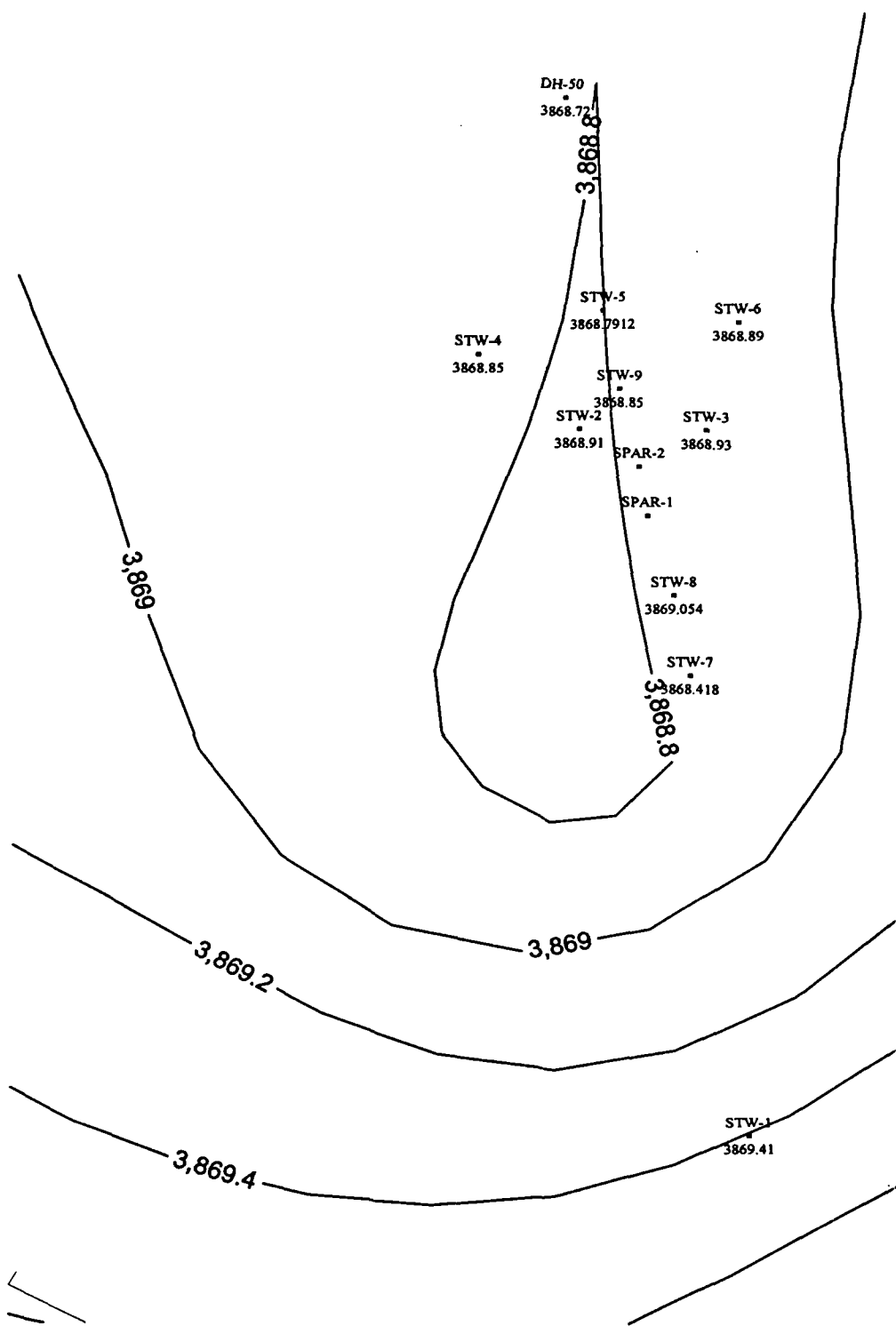
0 20 40

(feet)

INTERIM MEASURES
AIR SPARGING
PILOT TEST REPORT

OCTOBER 19, 2001
POTENTIOMETRIC SURFACE MAP

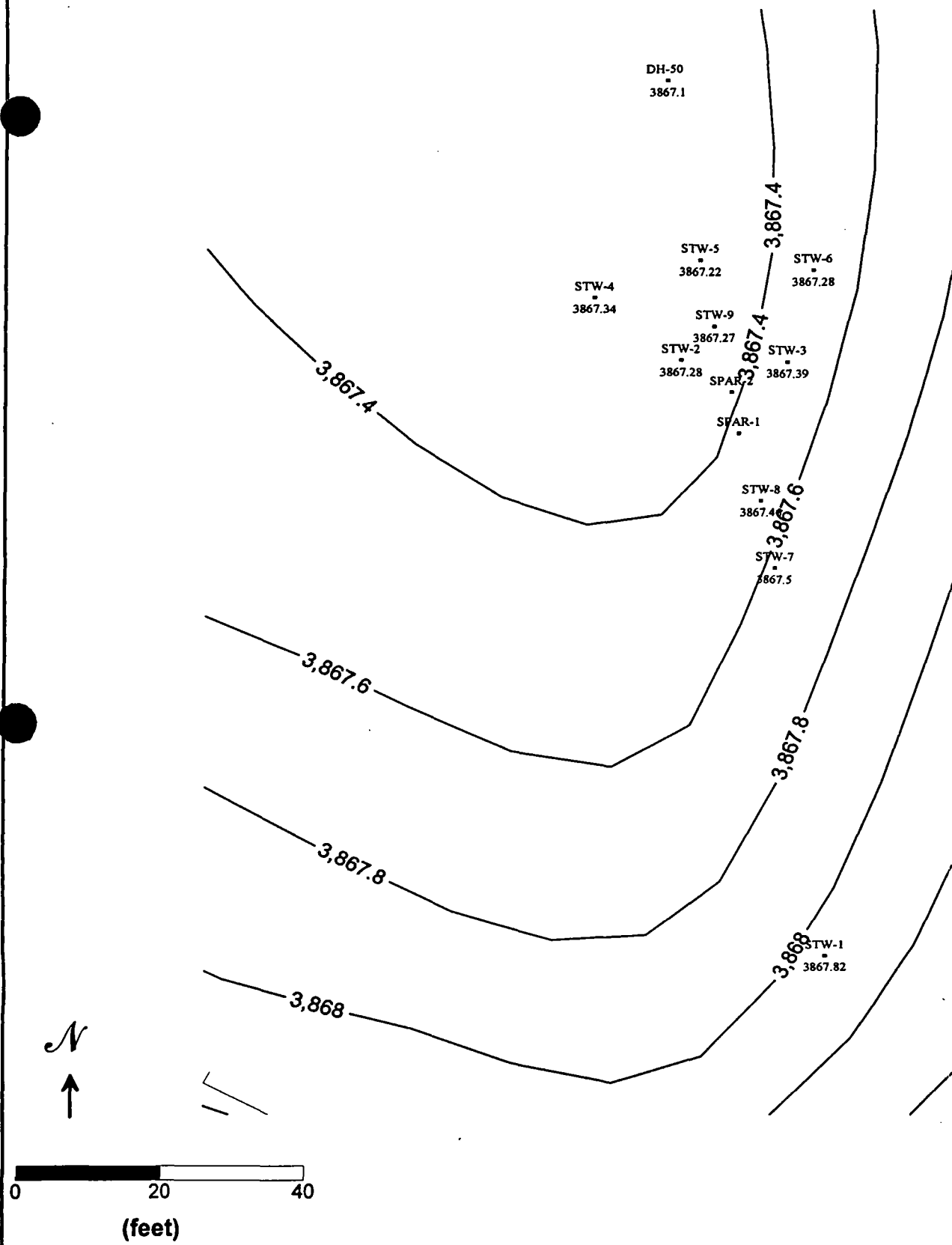
FIGURE



INTERIM MEASURES
AIR SPARGING
PILOT TEST REPORT

DECEMBER 7, 2001
POTENTIOMETRIC SURFACE MAP

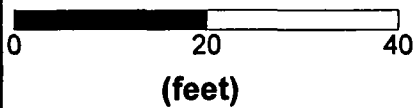
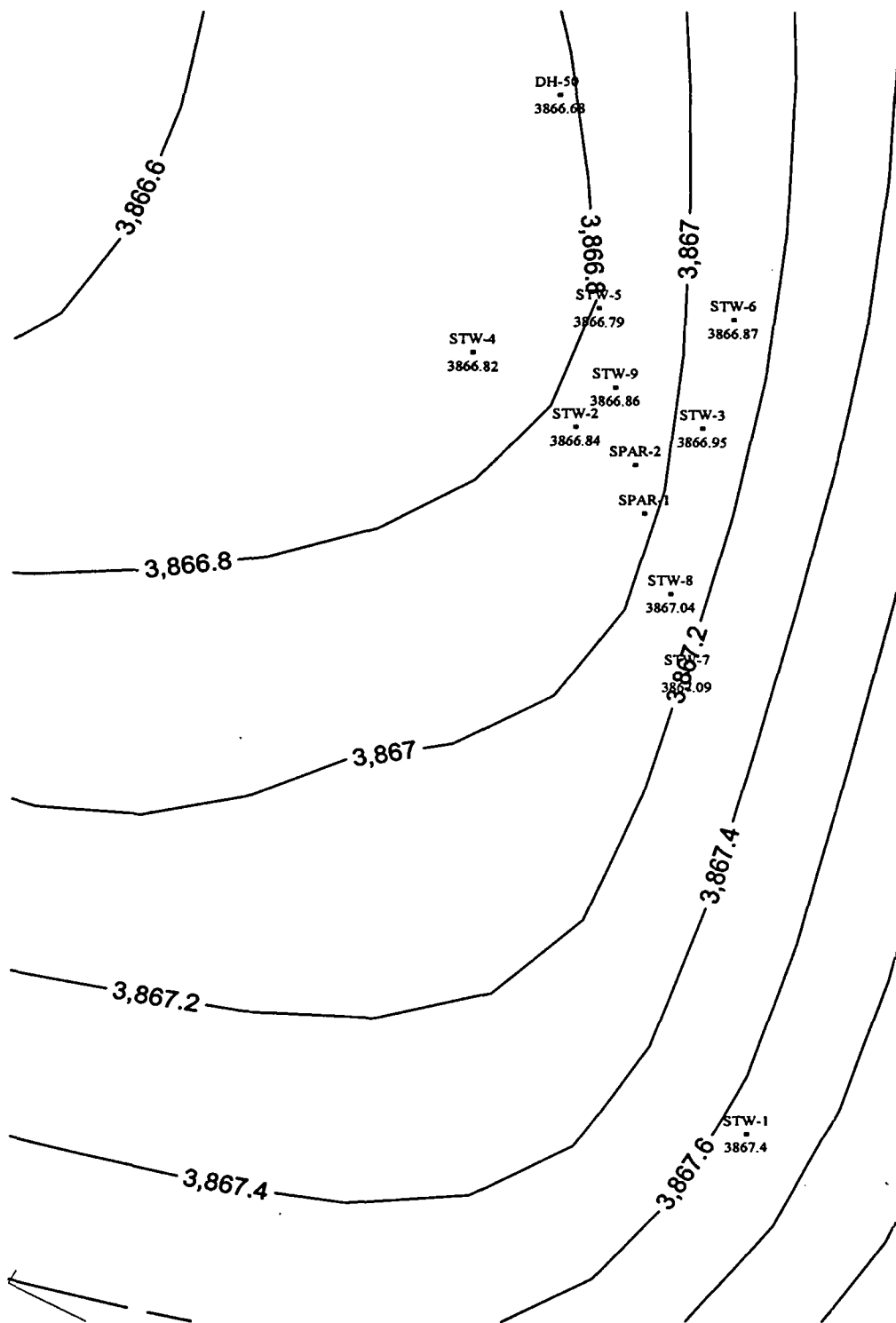
FIGURE



INTERIM MEASURES
AIR SPARGING
PILOT TEST REPORT

FEBRUARY 5, 2002
POTENTIOMETRIC SURFACE MAP
Pre-injection on 2/11/02

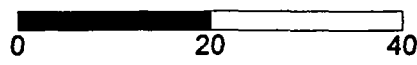
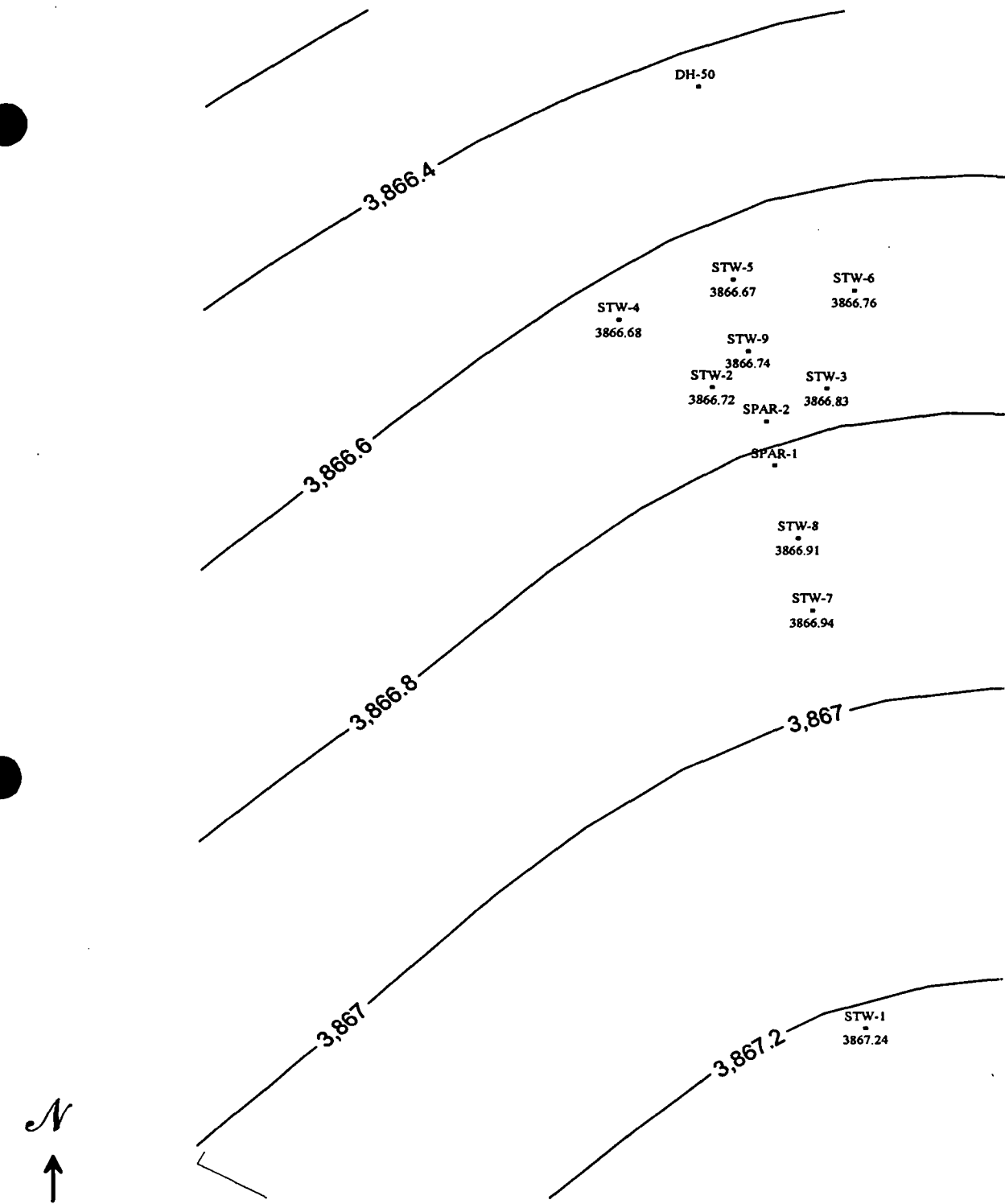
FIGURE



INTERIM MEASURES
AIR SPARGING
PILOT TEST REPORT

FEBRUARY 19, 2002
POTENTIOMETRIC SURFACE MAP
Post Injection on 2/11/02

FIGURE

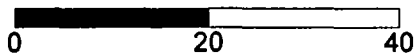
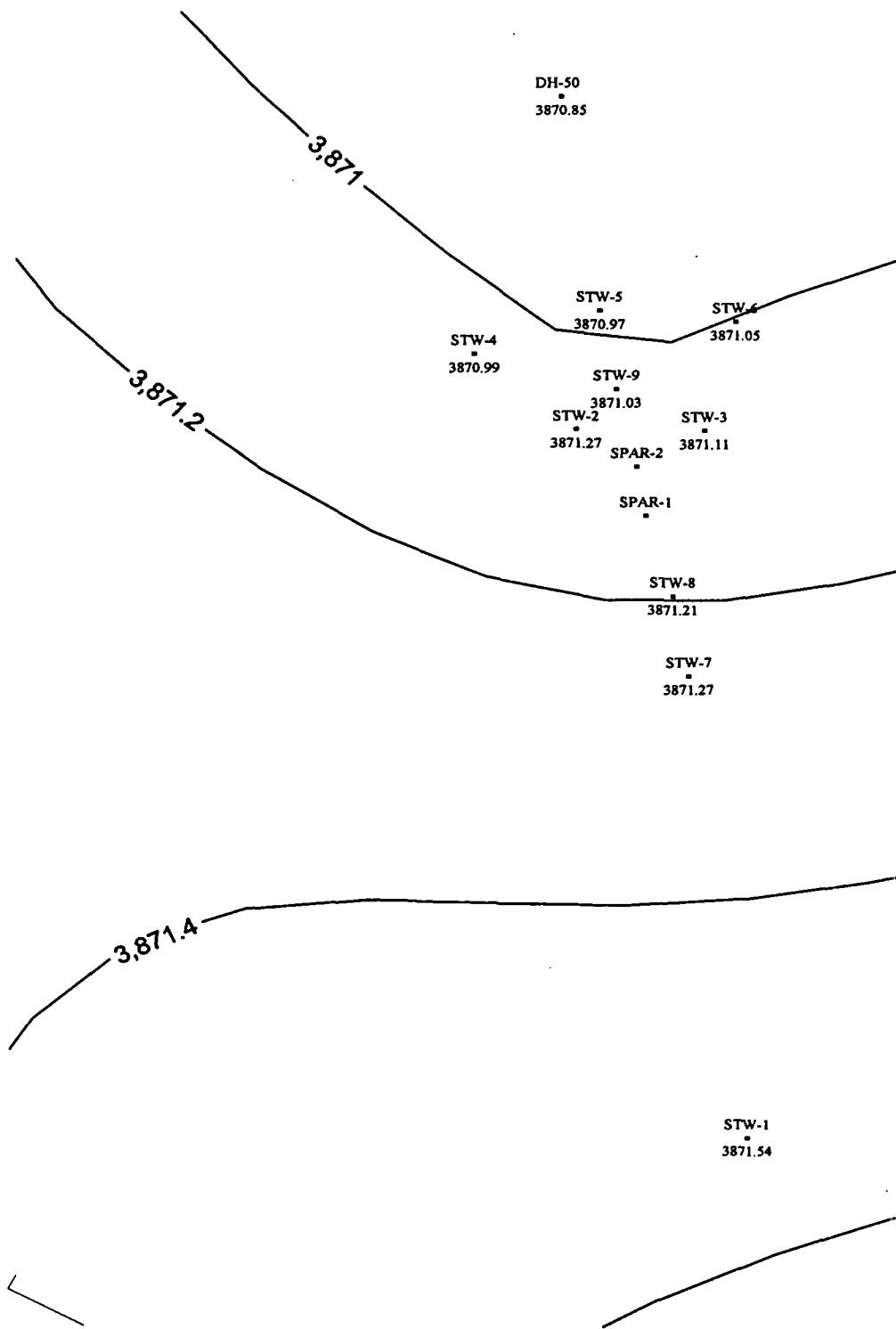


(feet)

INTERIM MEASURES
AIR SPARGING
PILOT TEST REPORT

JUNE 6, 2002
POTENTIOMETRIC SURFACE MAP
Pre-Weekly Injection Program
Starting 7/17/02

FIGURE

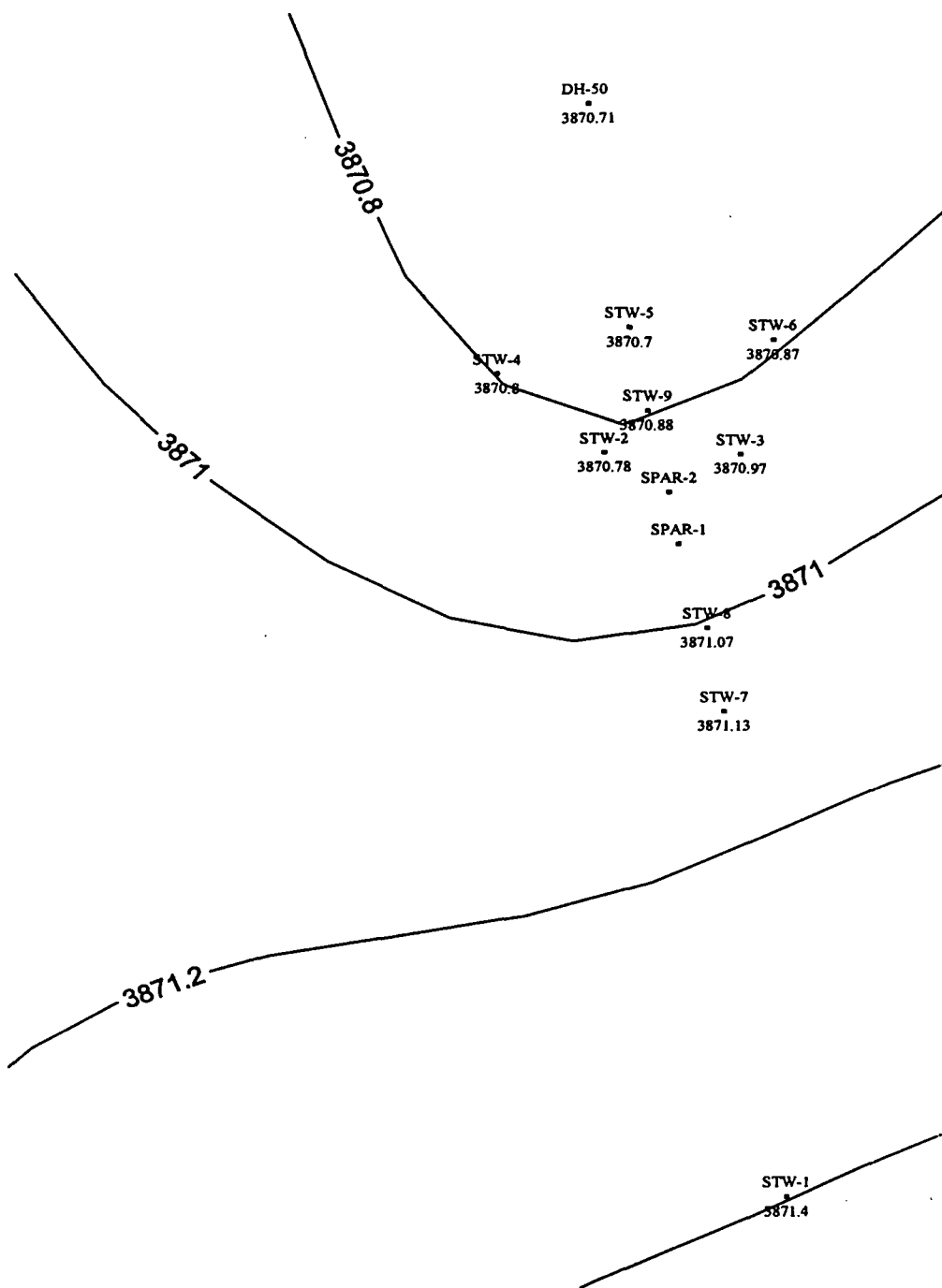


(feet)

INTERIM MEASURES
AIR SPARGING
PILOT TEST REPORT

AUGUST 8, 2002
POTENTIOMETRIC SURFACE MAP
Prior to 5th Iron Injection

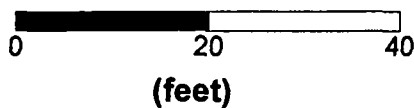
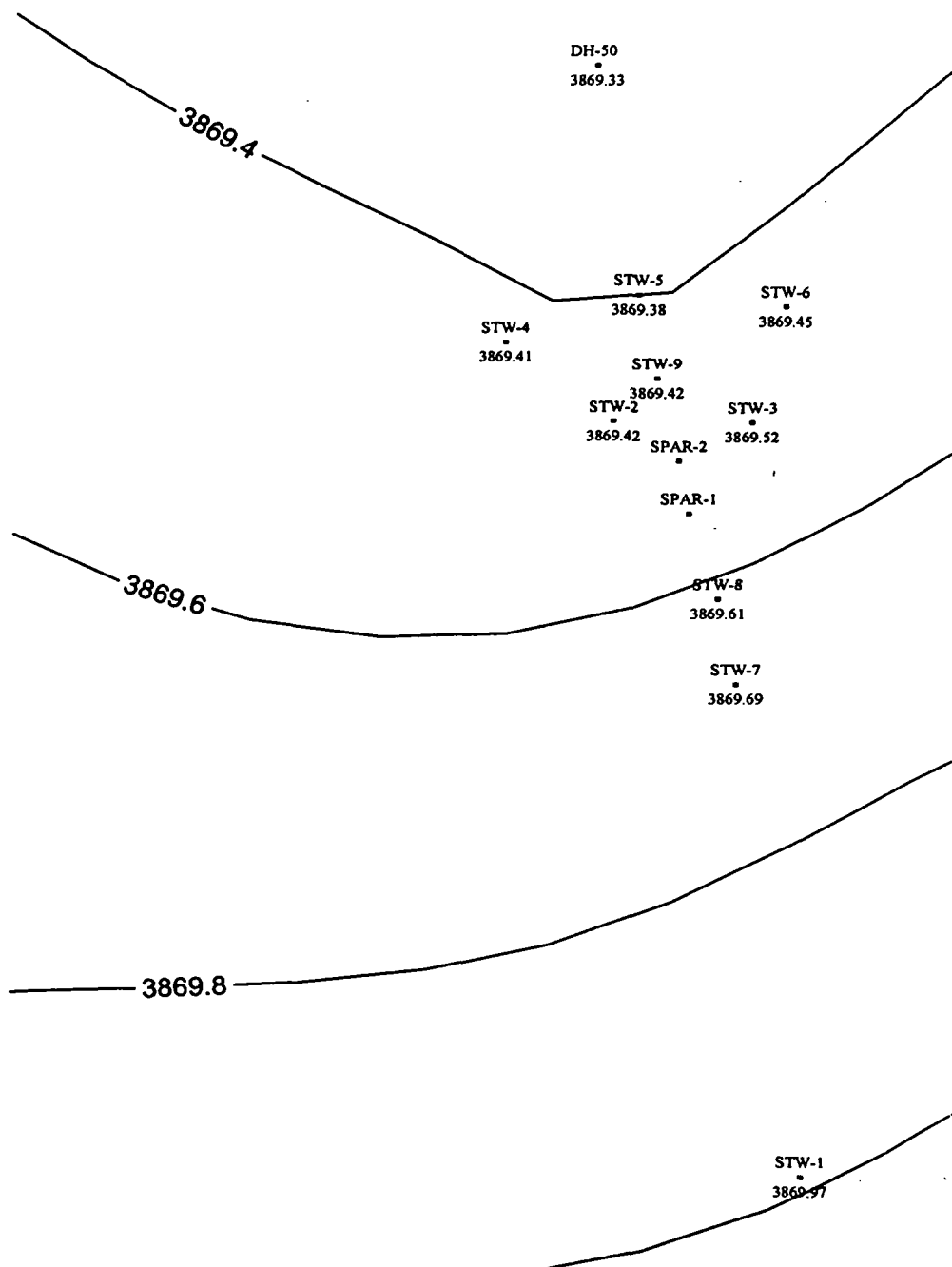
FIGURE



INTERIM MEASURES
AIR SPARGING
PILOT TEST REPORT

SEPTEMBER 26, 2002
POTENTIOMETRIC SURFACE MAP
Following Eight Iron Injections

FIGURE



INTERIM MEASURES
AIR SPARGING
PILOT TEST REPORT

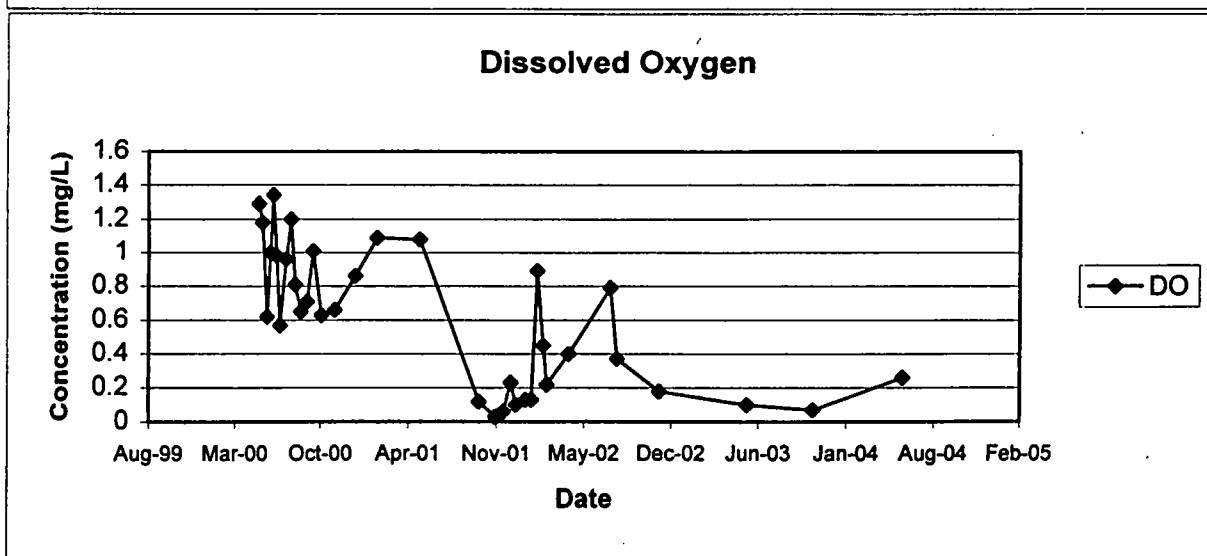
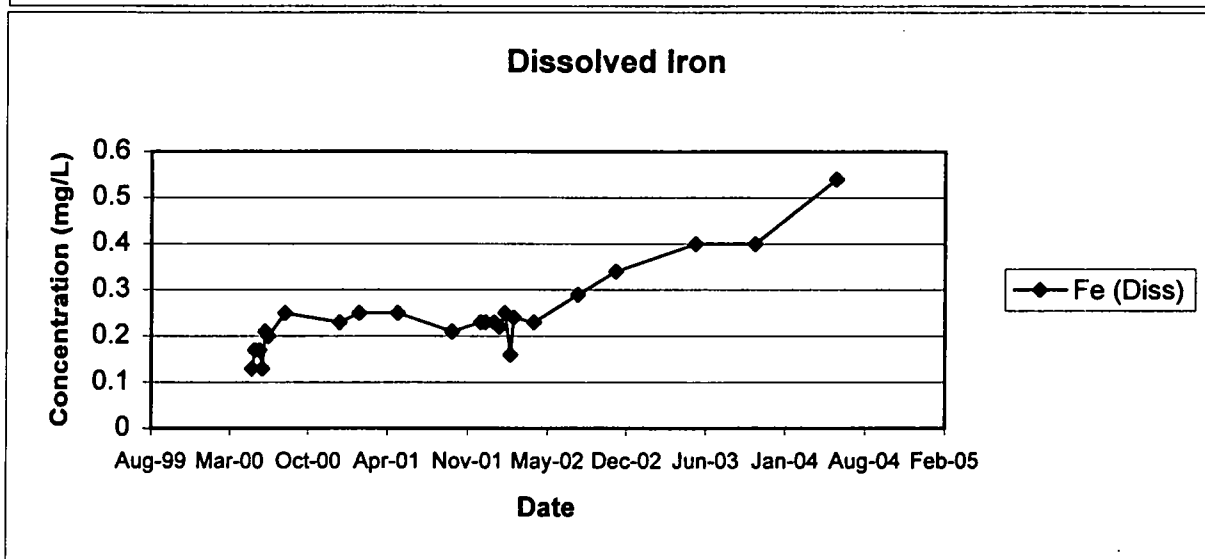
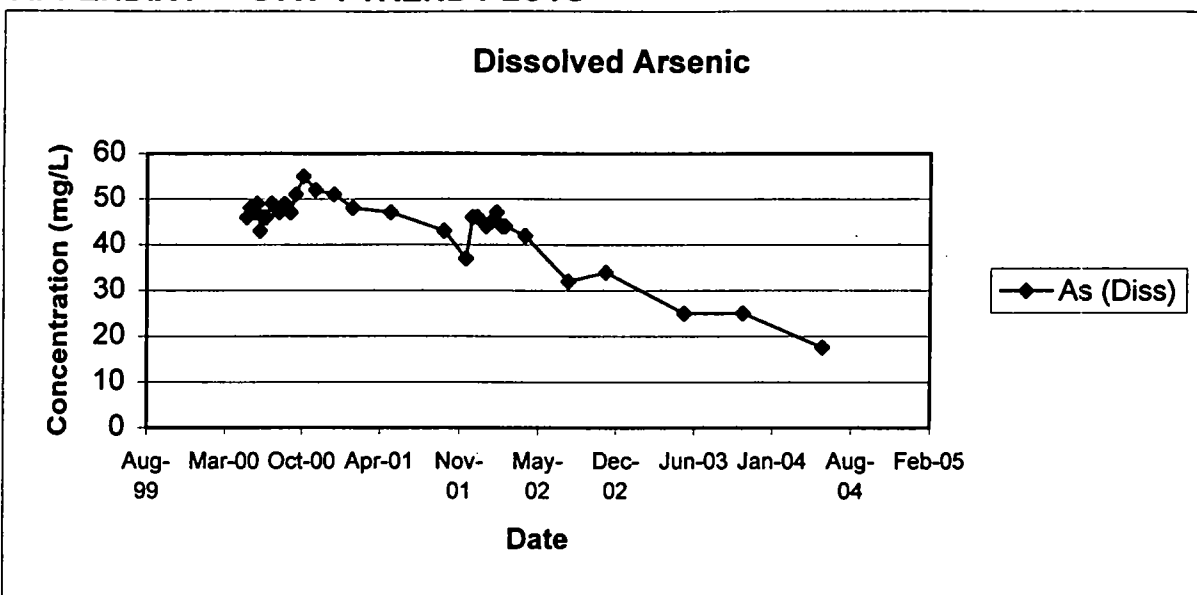
NOVEMBER 13, 2002
POTENTIOMETRIC SURFACE MAP
Following Eleven Iron Injections

FIGURE

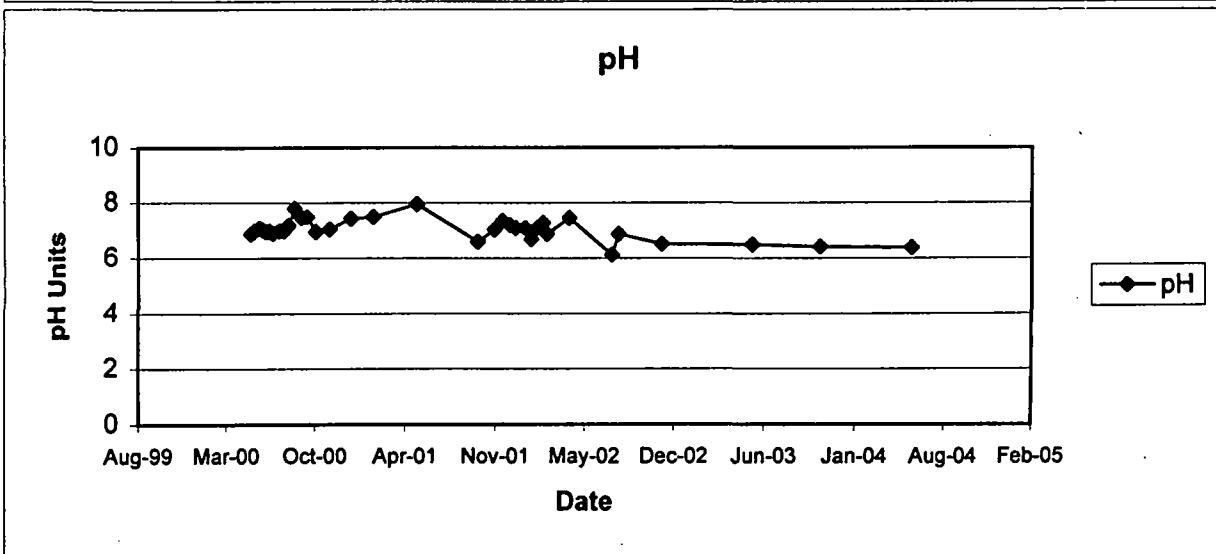
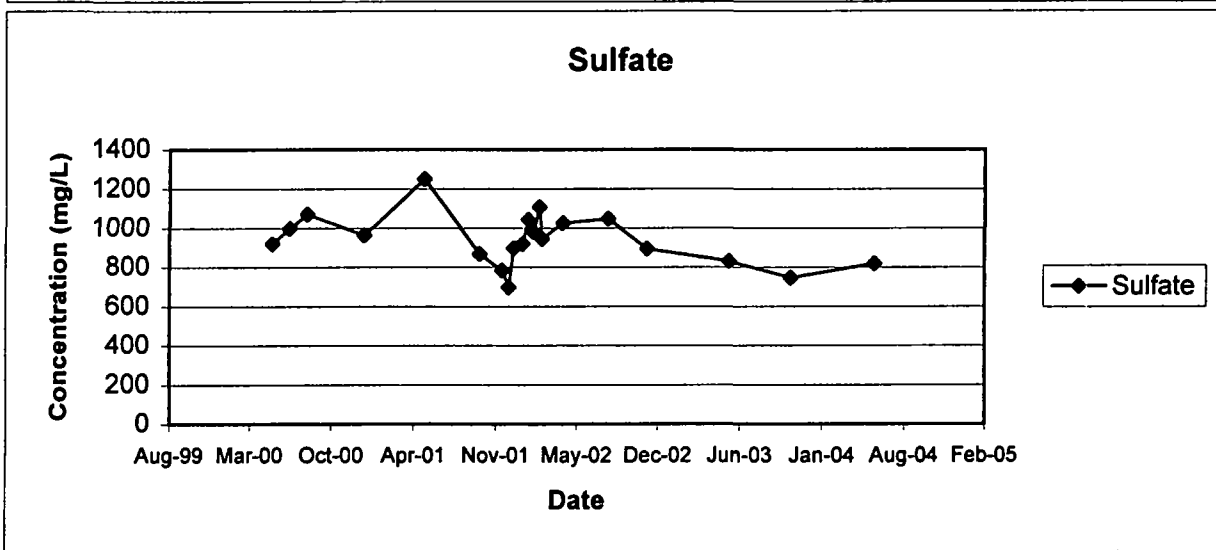
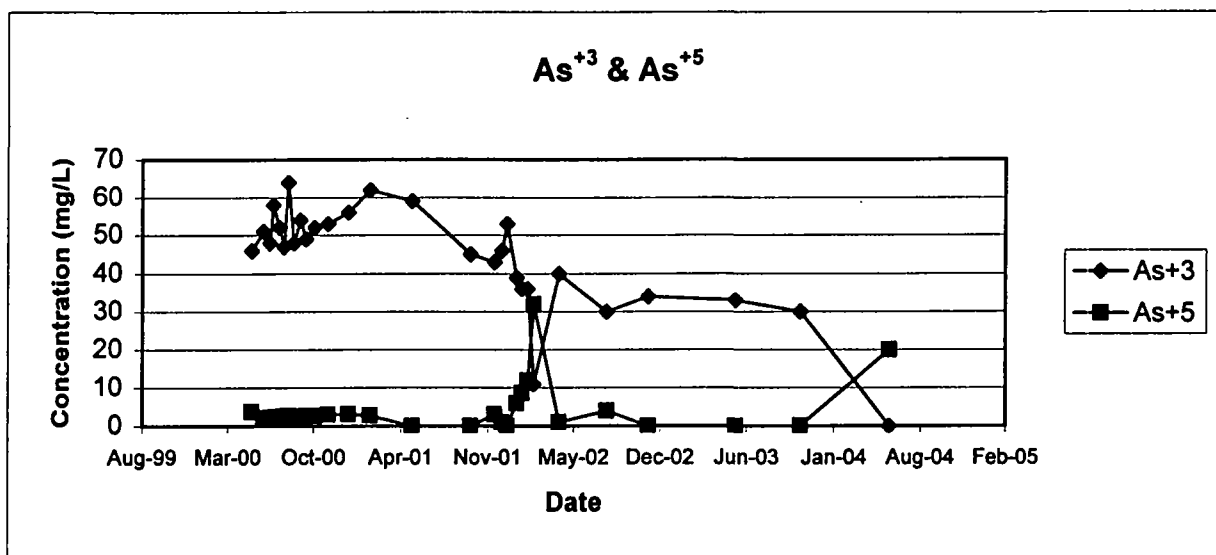
APPENDIX F

WATER QUALITY TREND GRAPHS FOR SPAR-3 AND SPAR-1 AND SPAR-2 SPARGE SYSTEMS

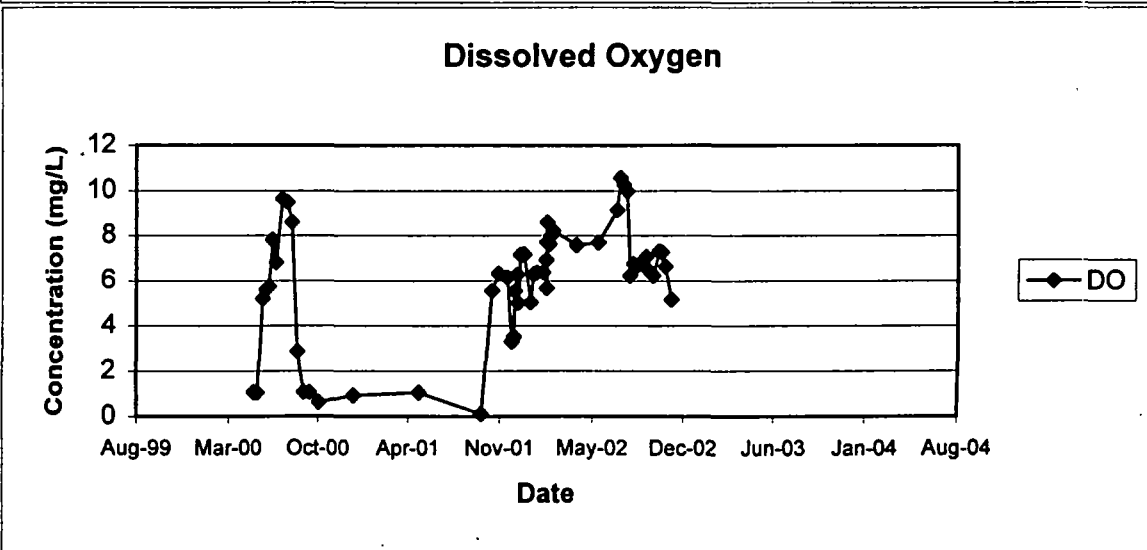
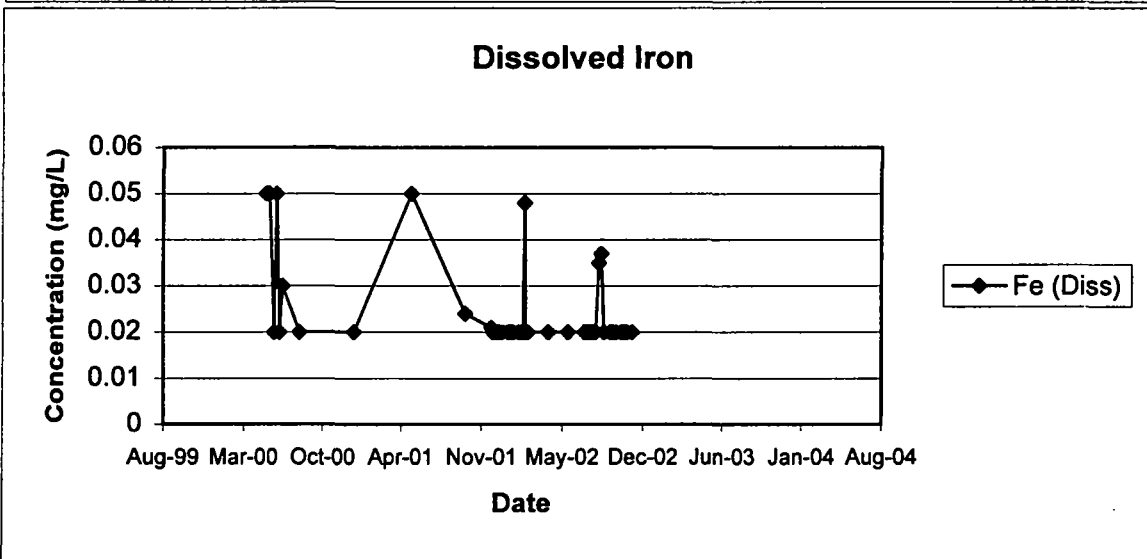
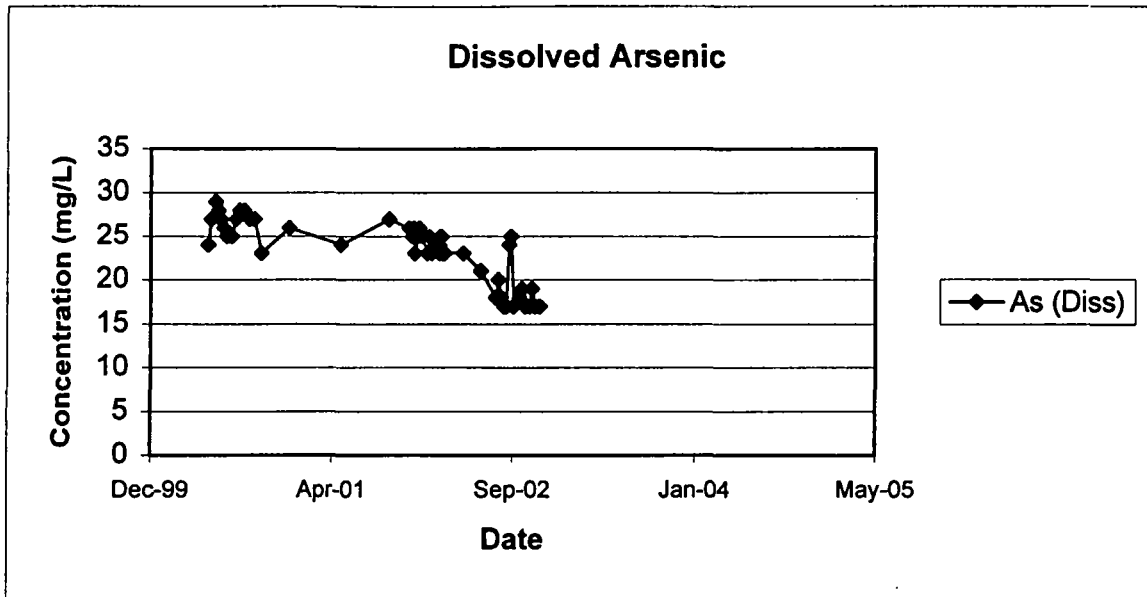
APPENDIX F - STW-1 TREND PLOTS



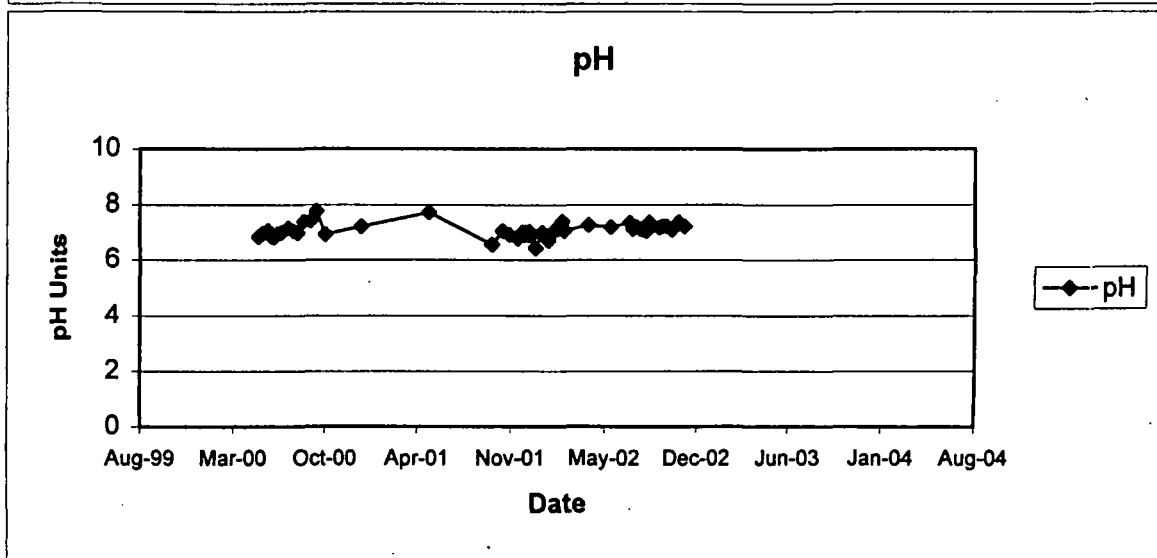
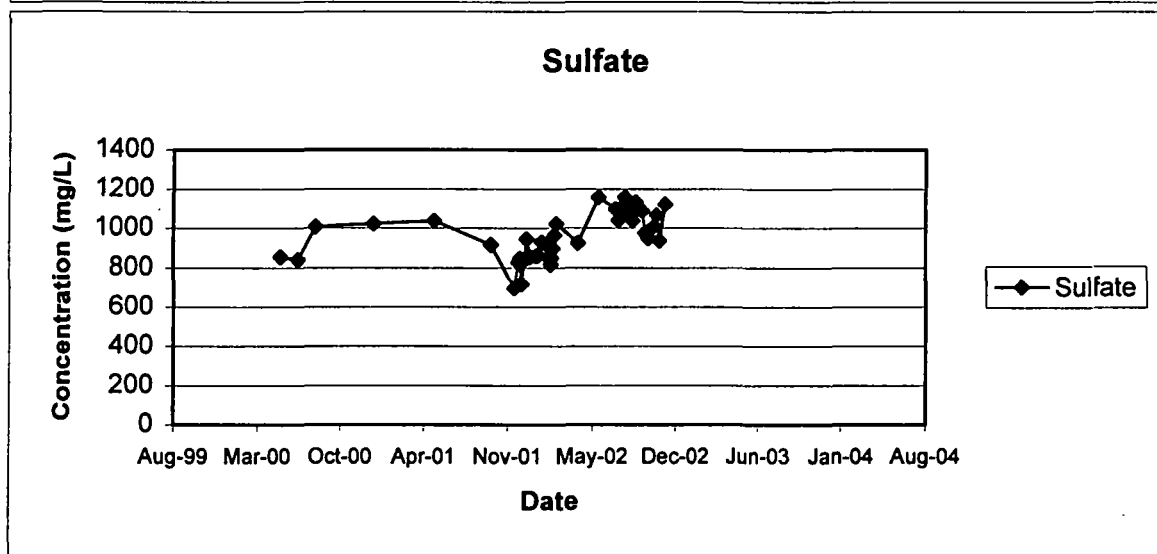
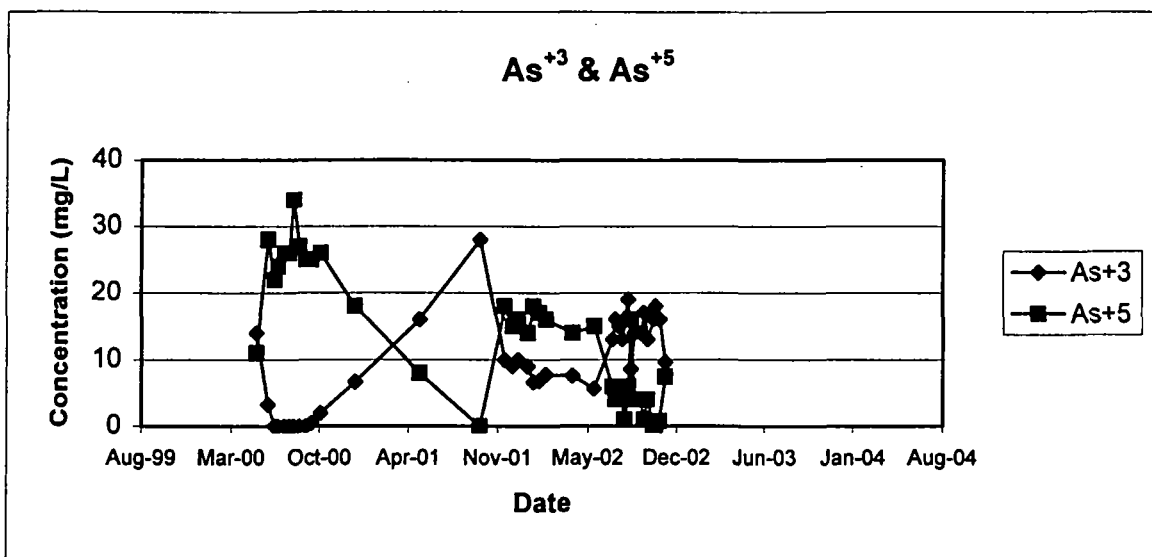
APPENDIX F - STW-1 TREND PLOTS



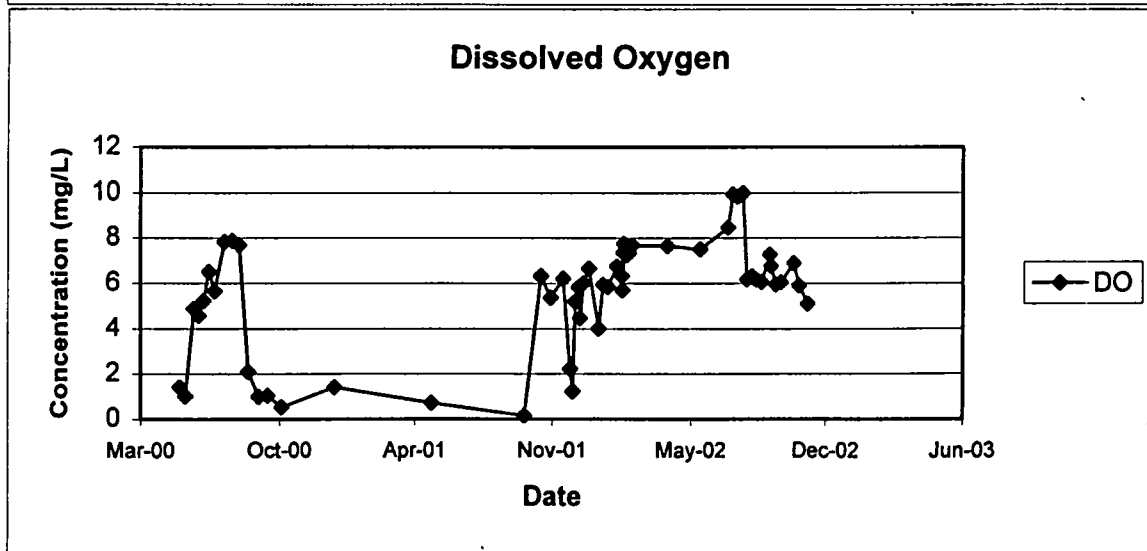
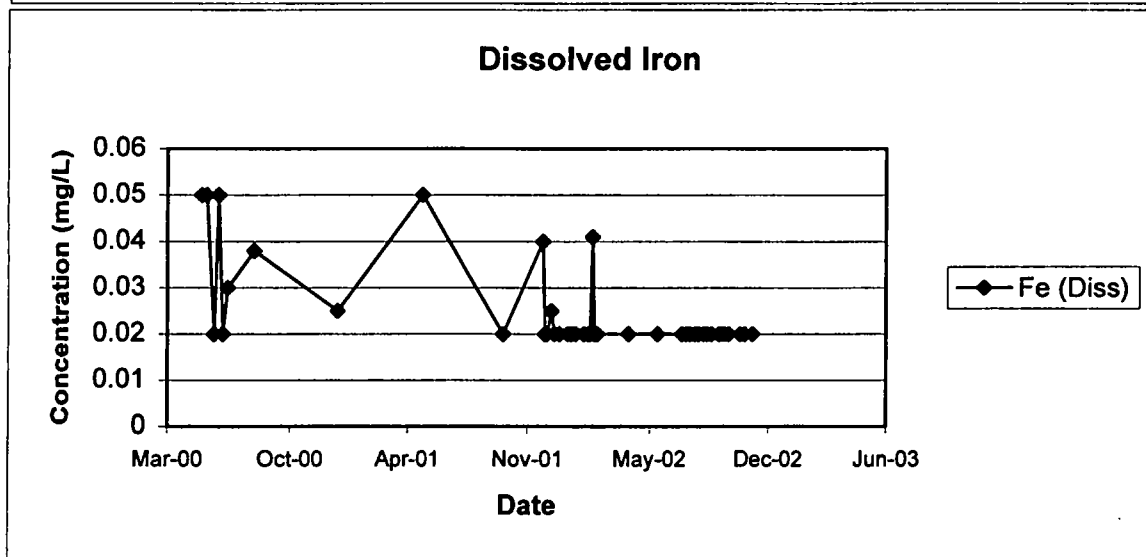
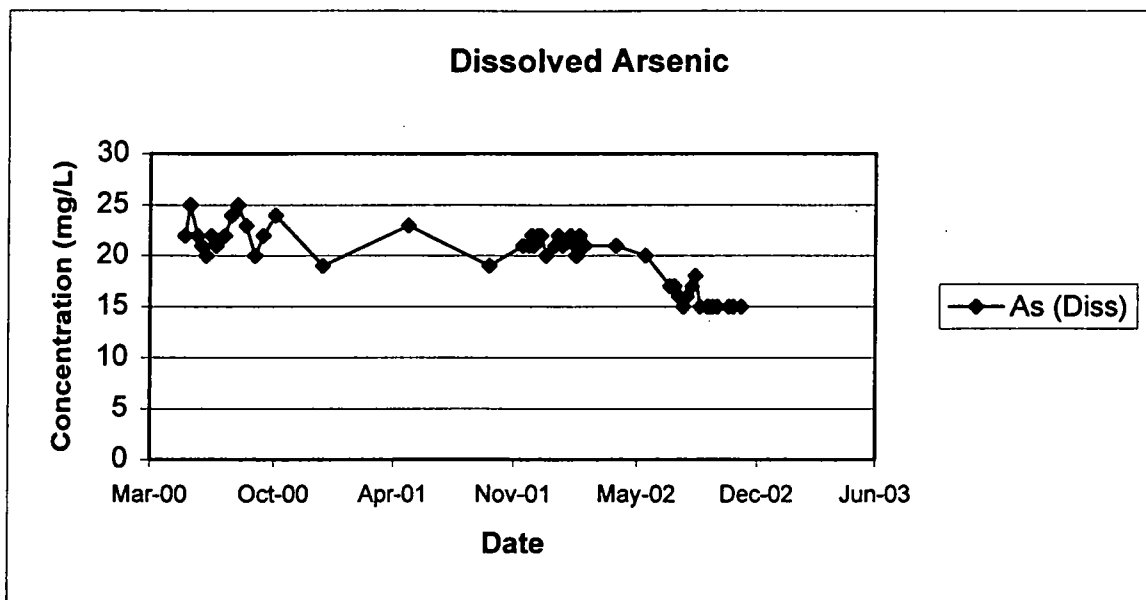
APPENDIX F - STW-2 TREND PLOTS



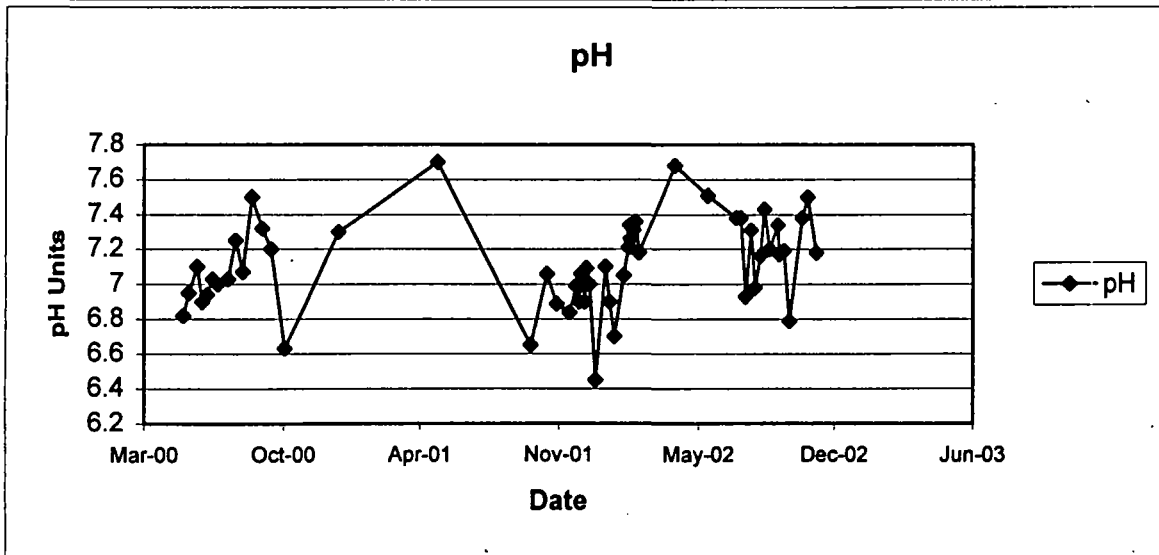
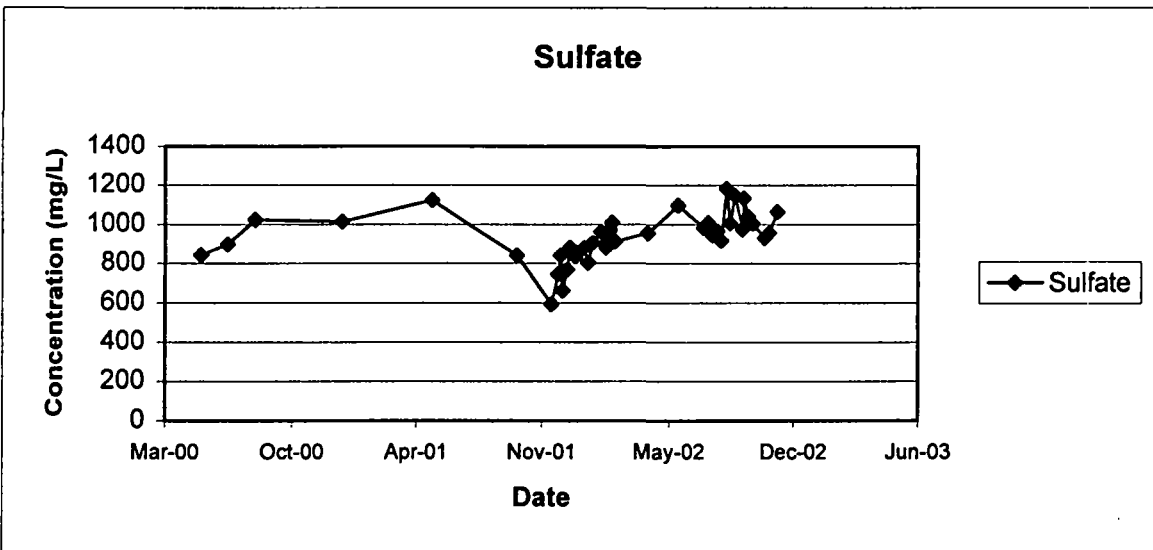
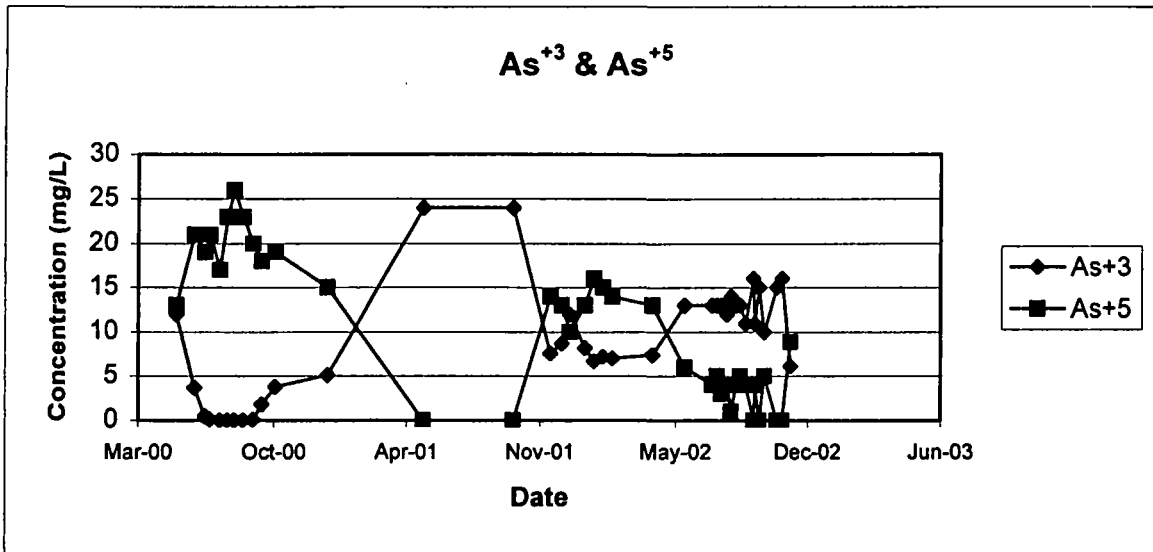
APPENDIX F - STW-2 TREND PLOTS



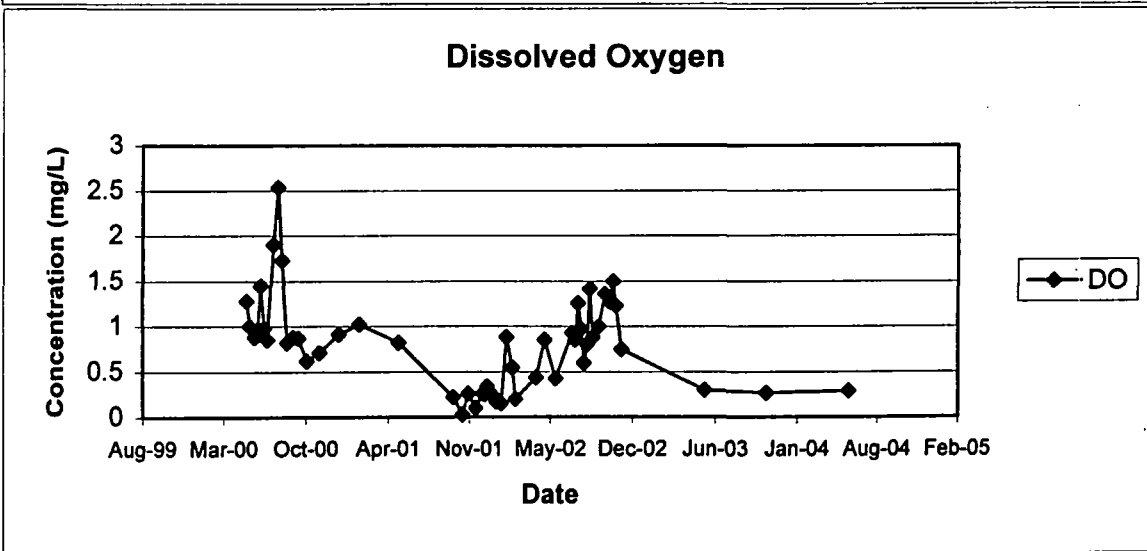
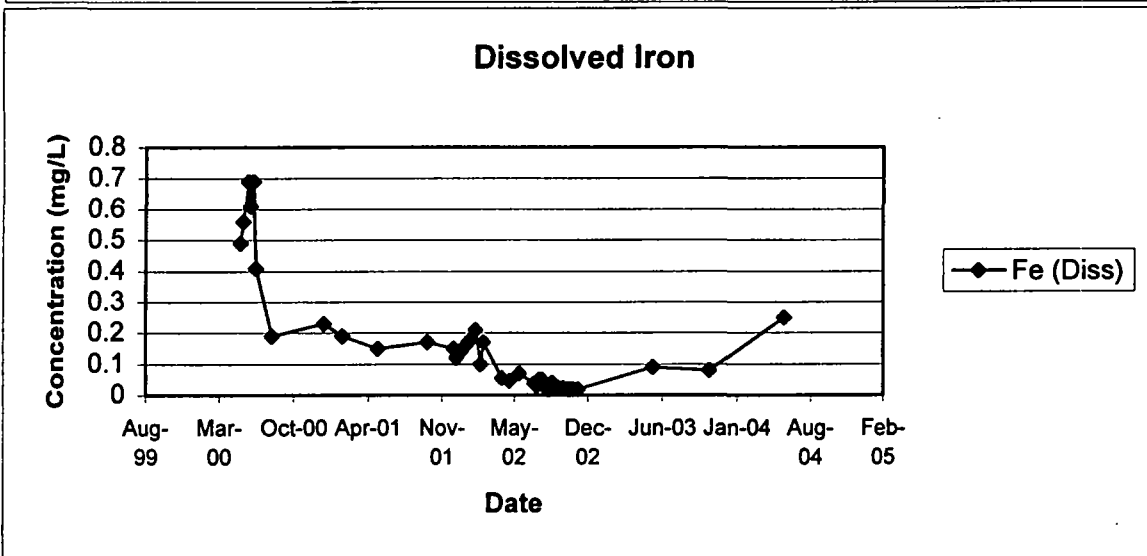
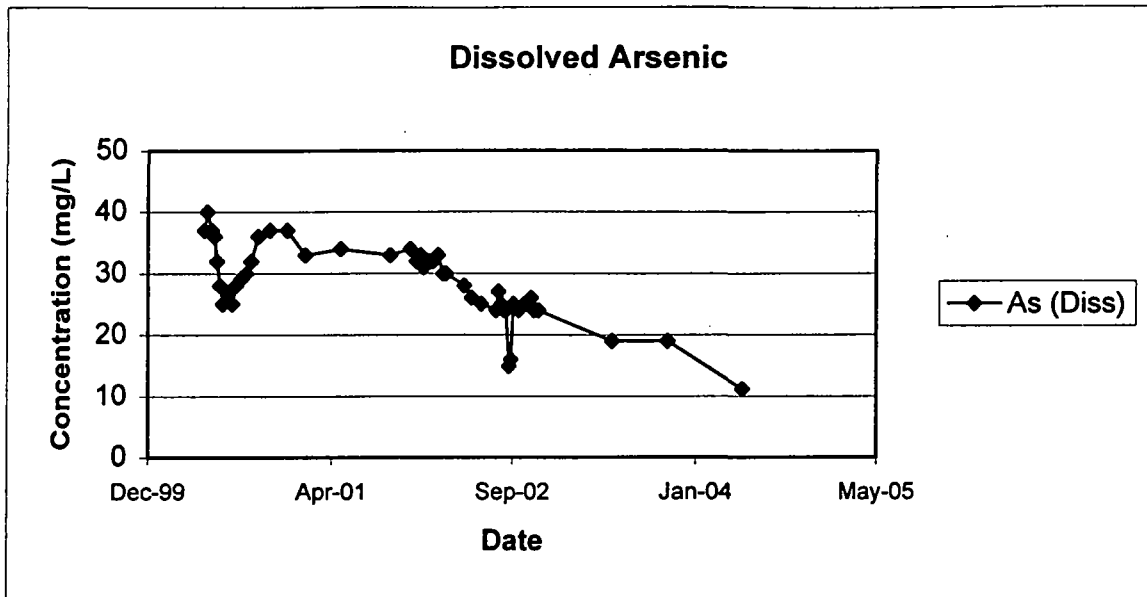
APPENDIX F - STW-3 TREND PLOTS



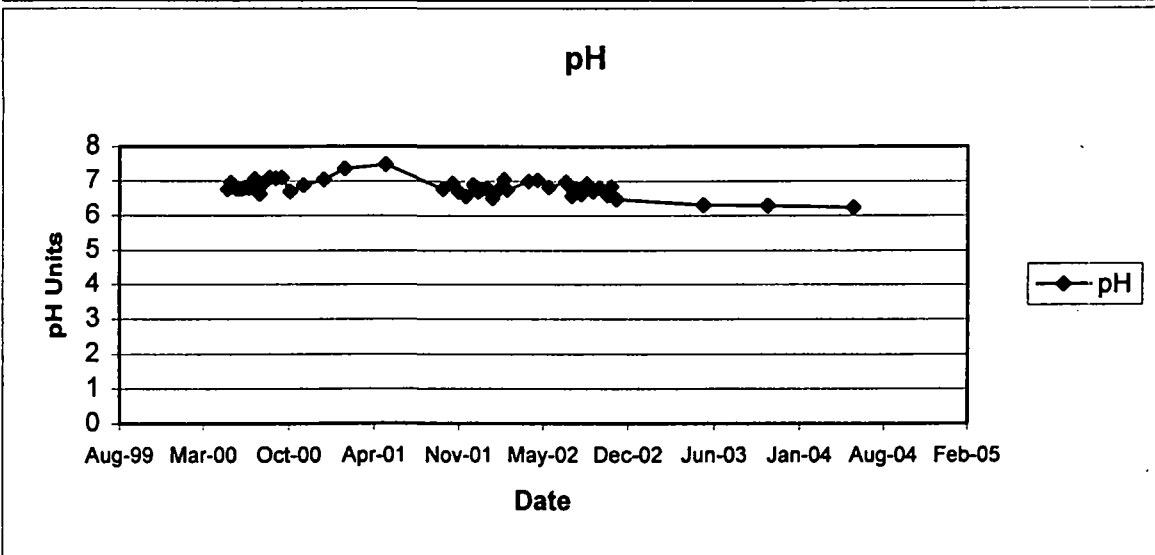
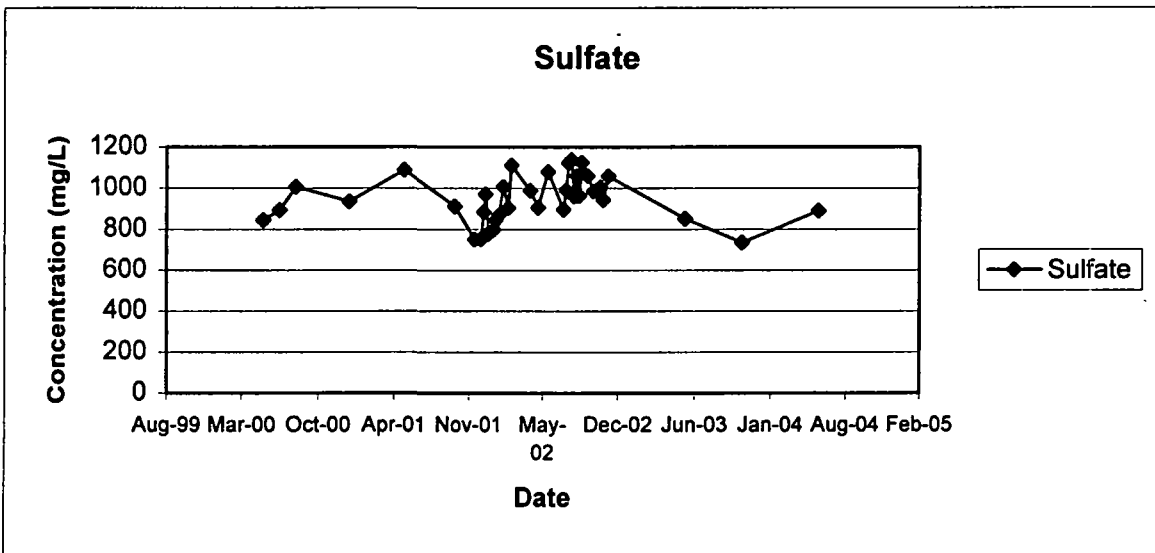
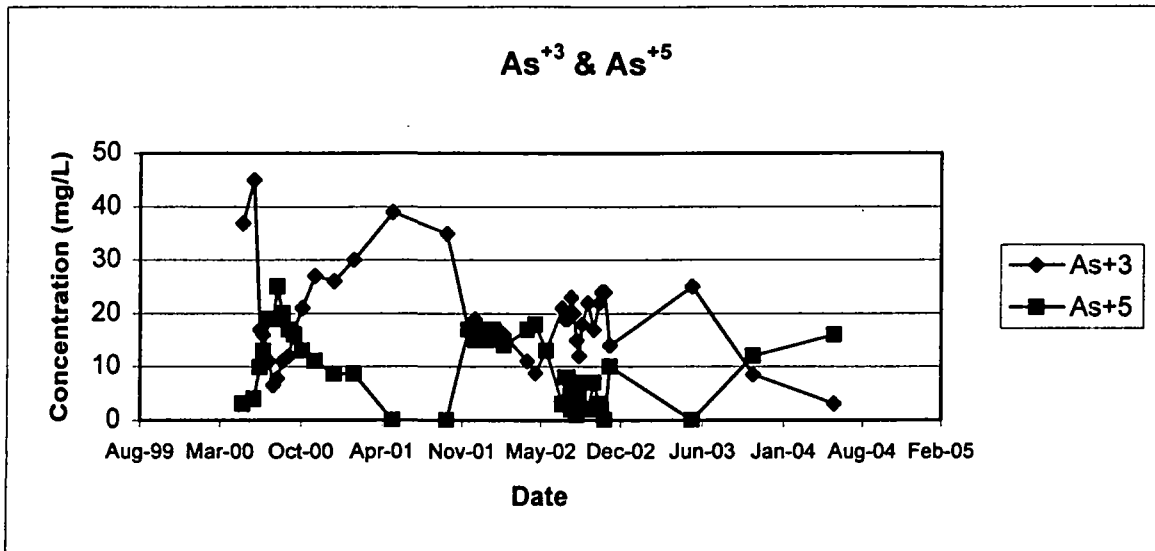
APPENDIX F - STW-3 TREND PLOTS



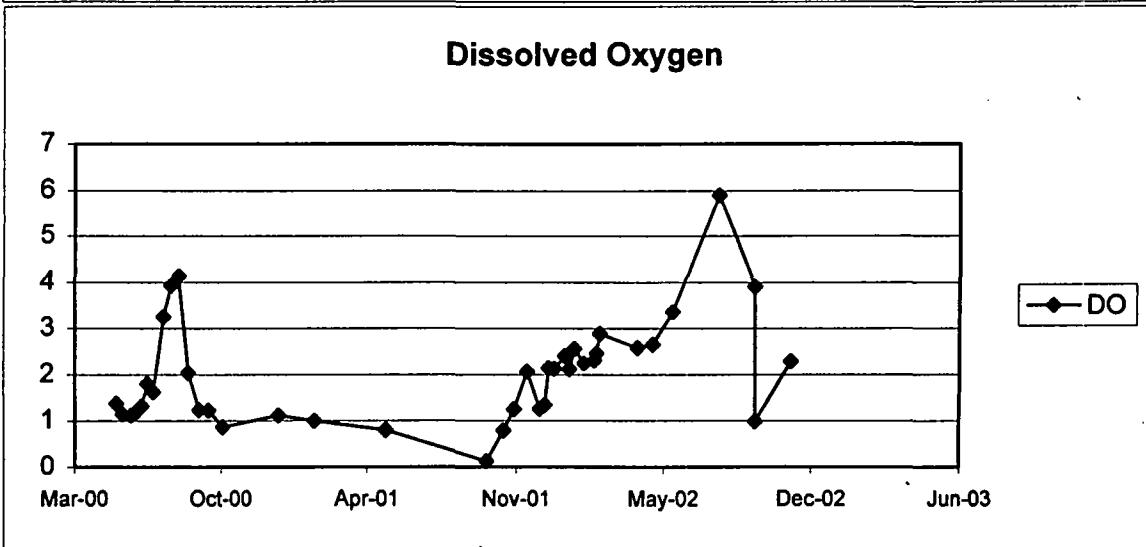
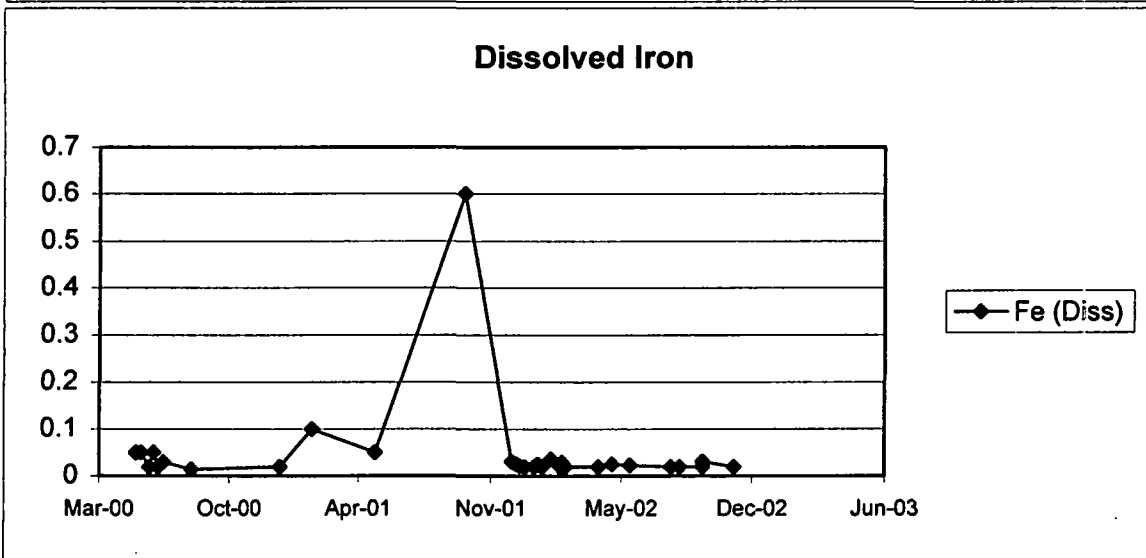
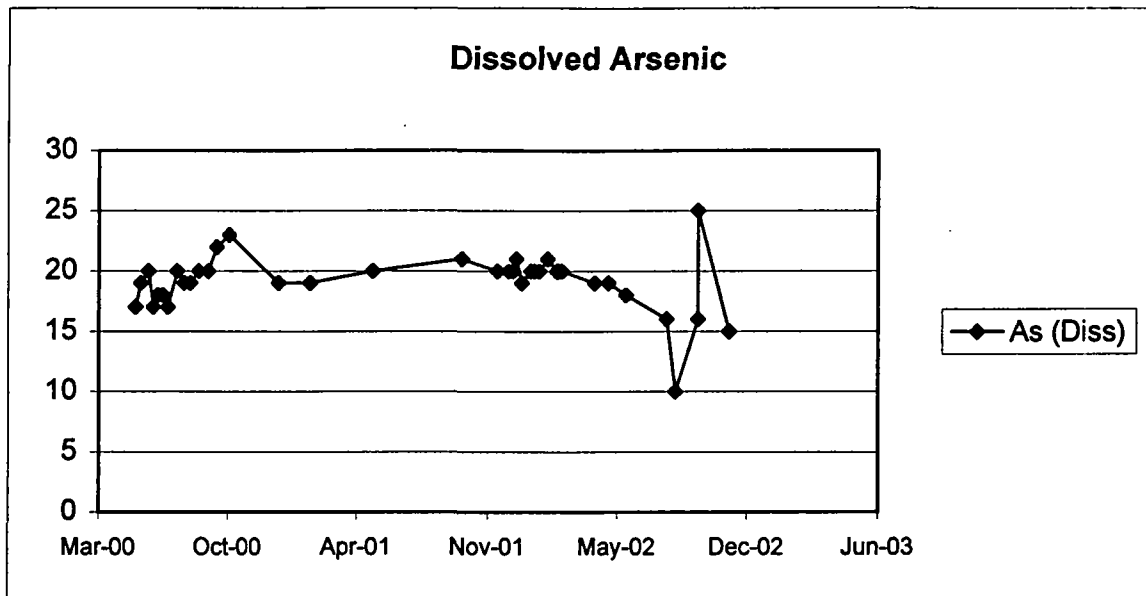
APPENDIX F- STW-4 TREND PLOTS



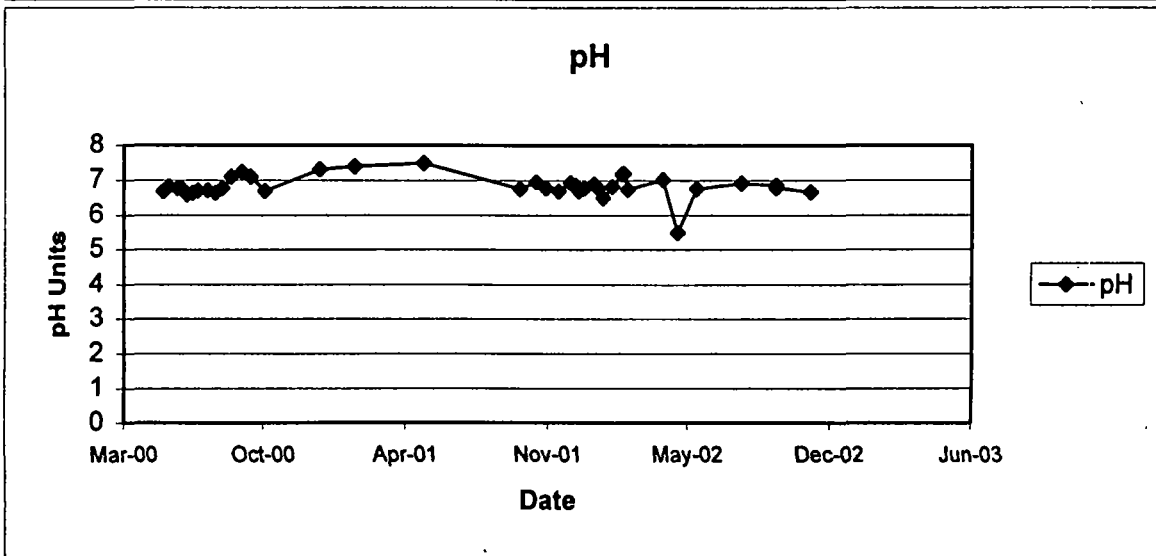
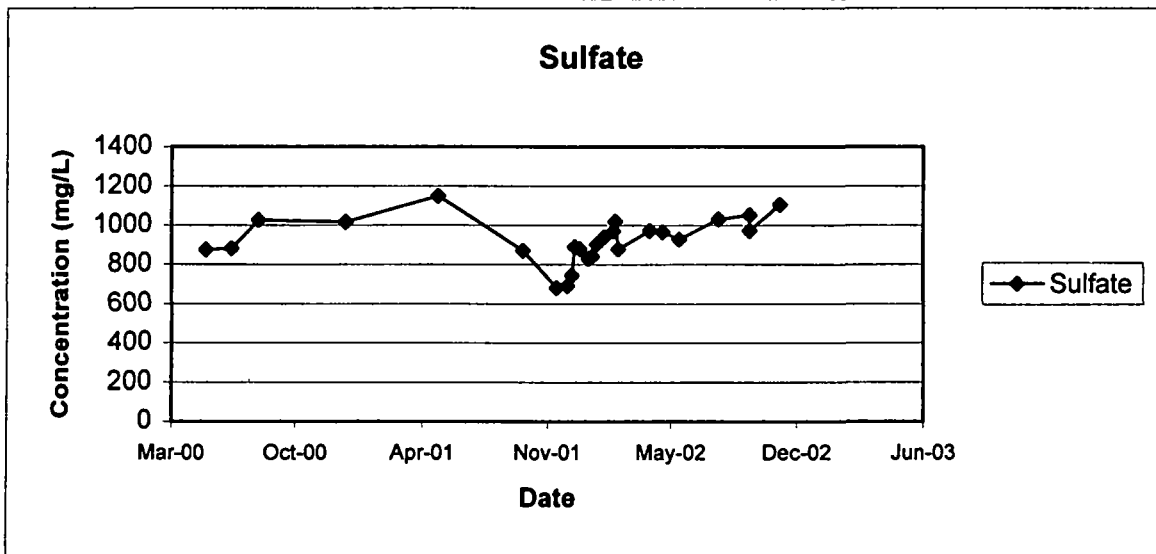
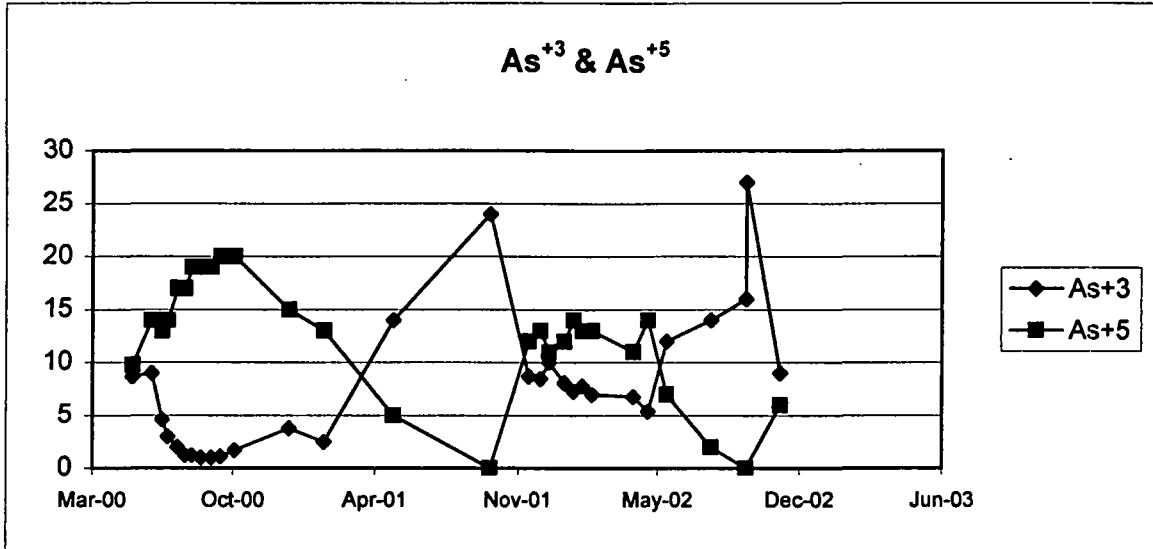
APPENDIX F - STW-4 TREND PLOTS



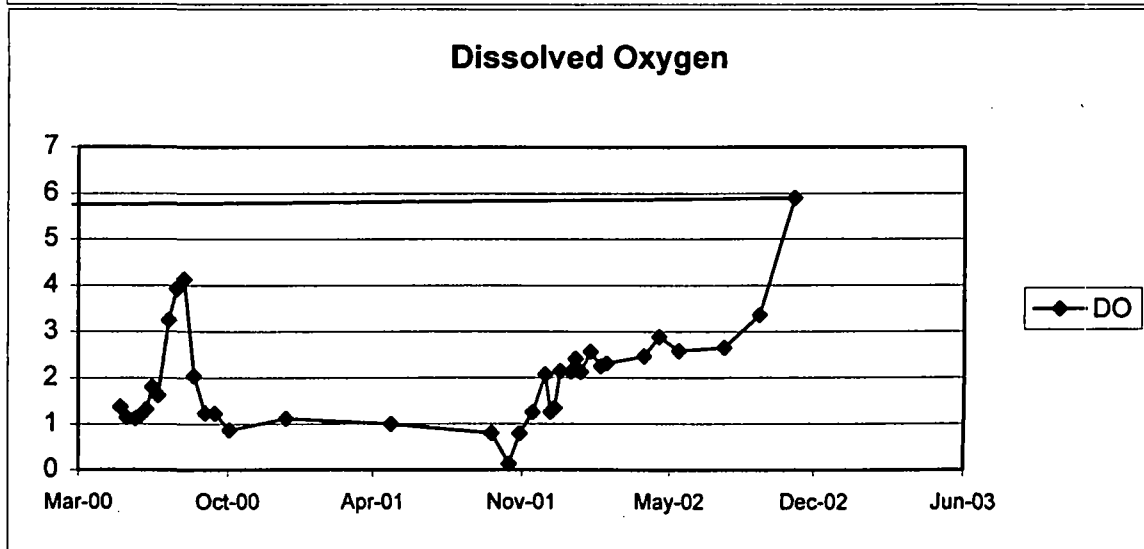
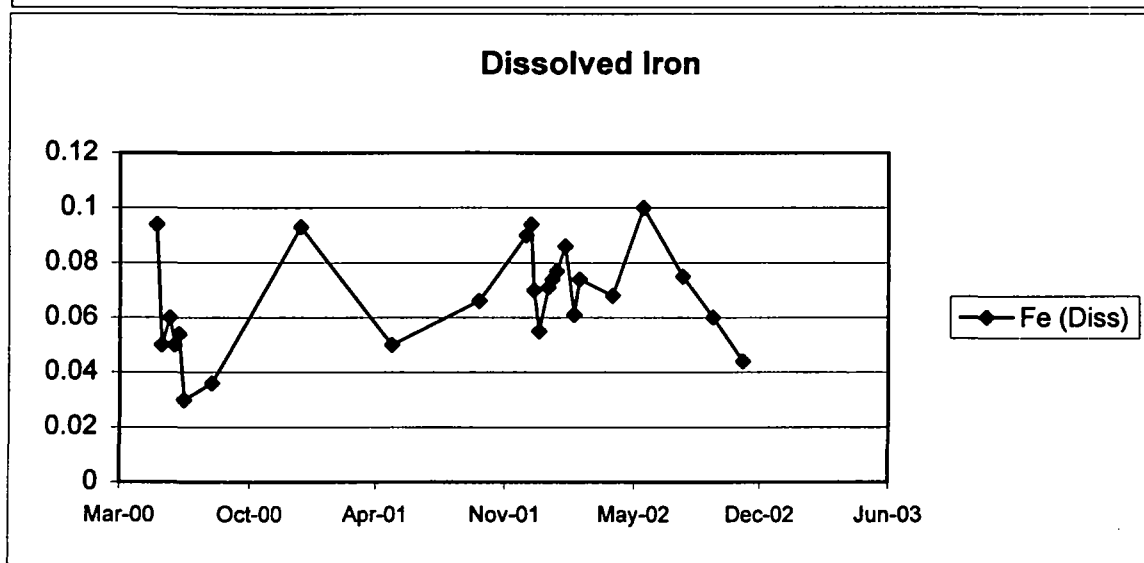
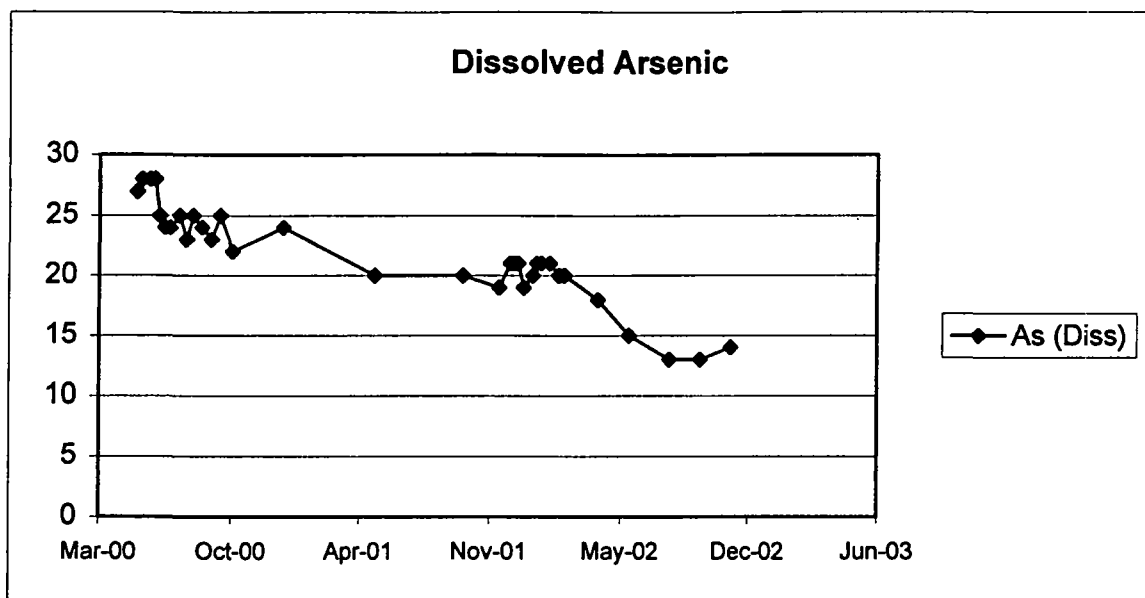
APPENDIX F - STW-5 TREND PLOTS



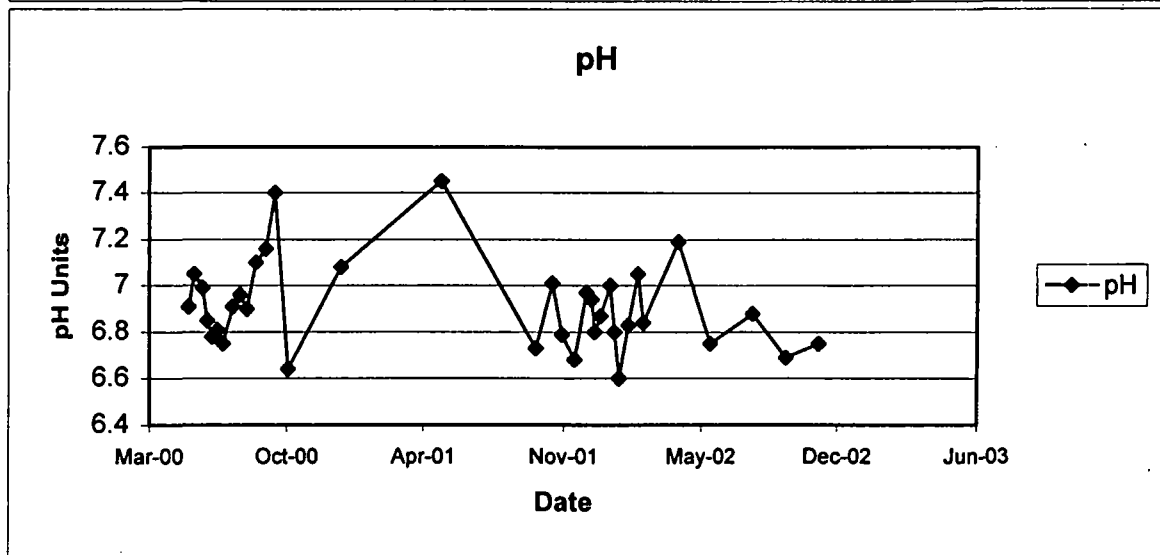
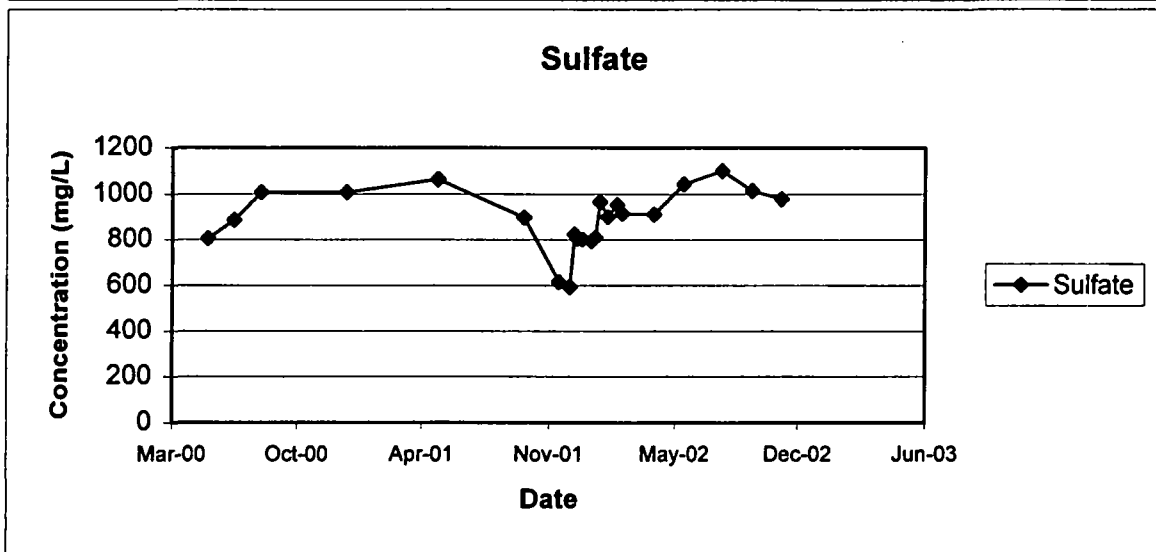
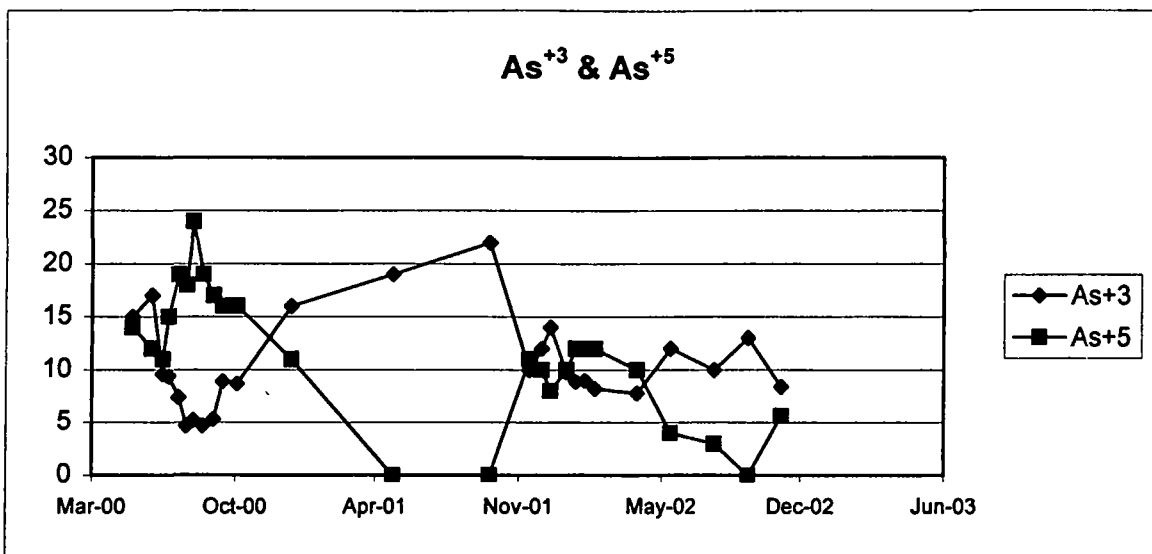
APPENDIX F - STW-5 TREND PLOTS



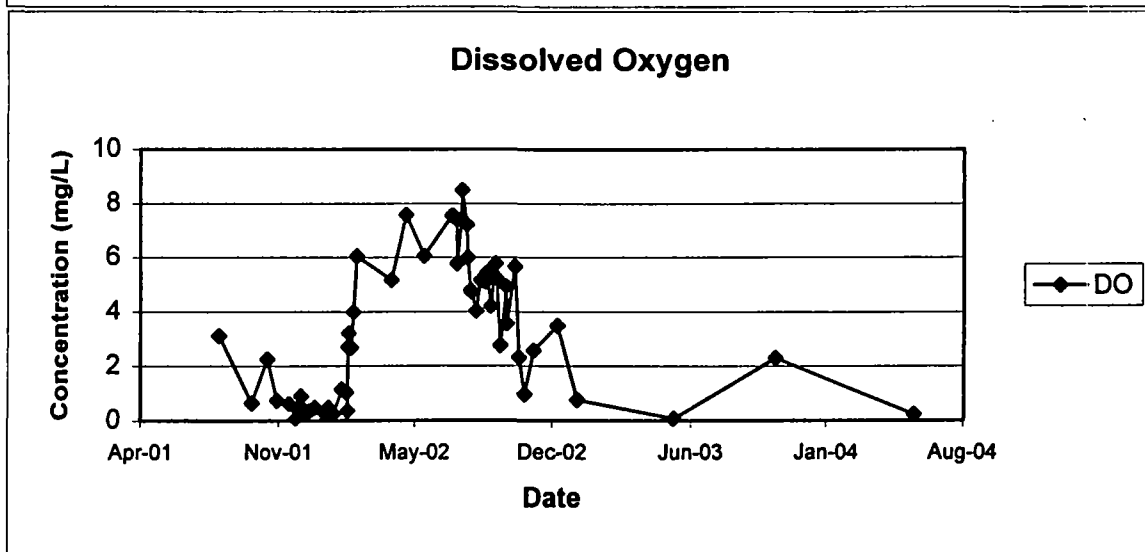
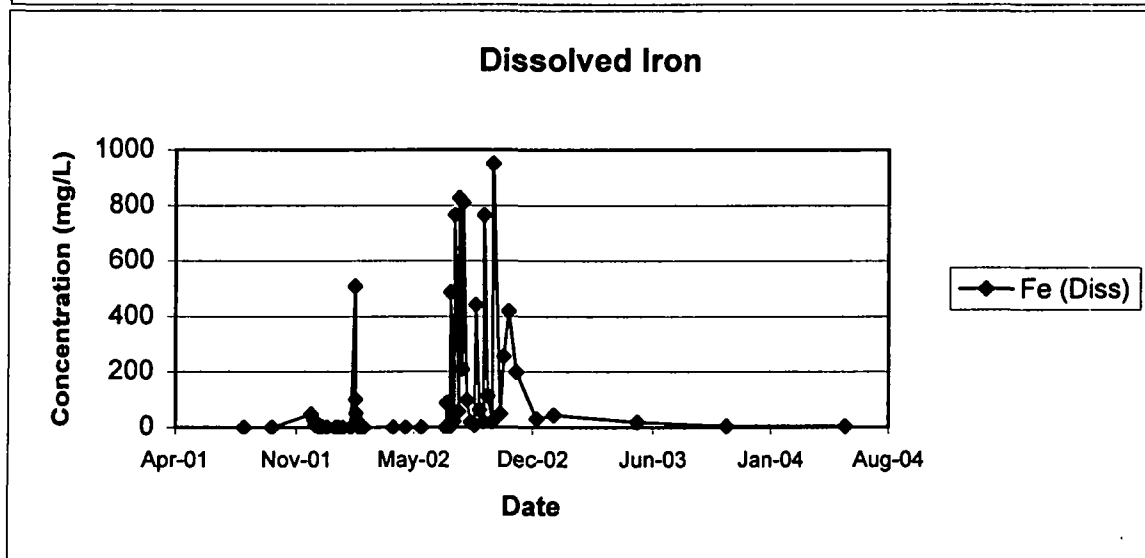
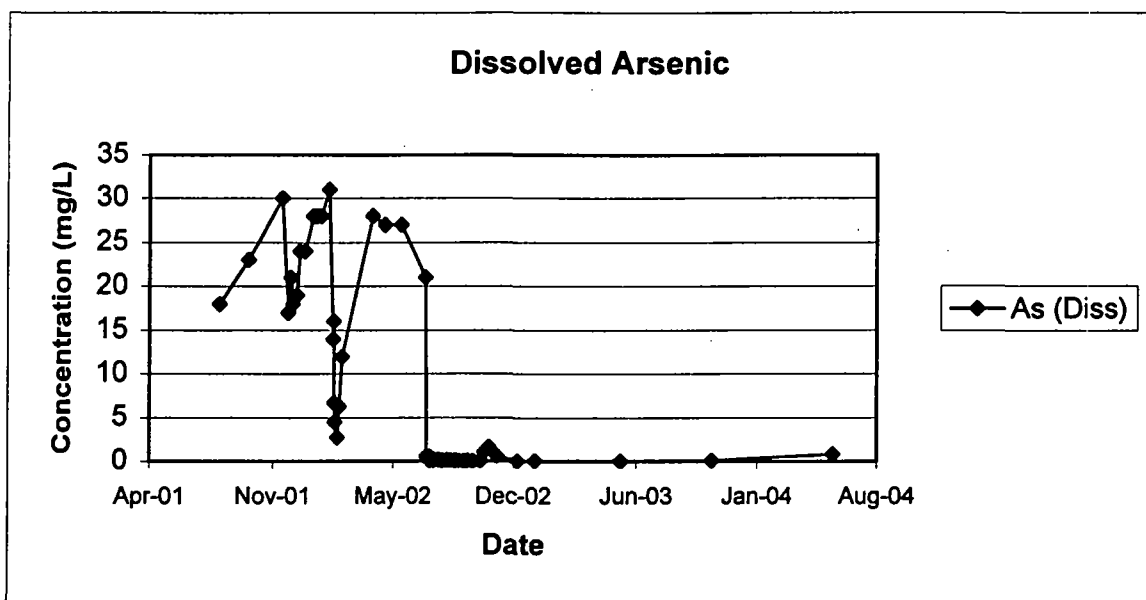
APPENDIX F - STW-6 TREND PLOTS



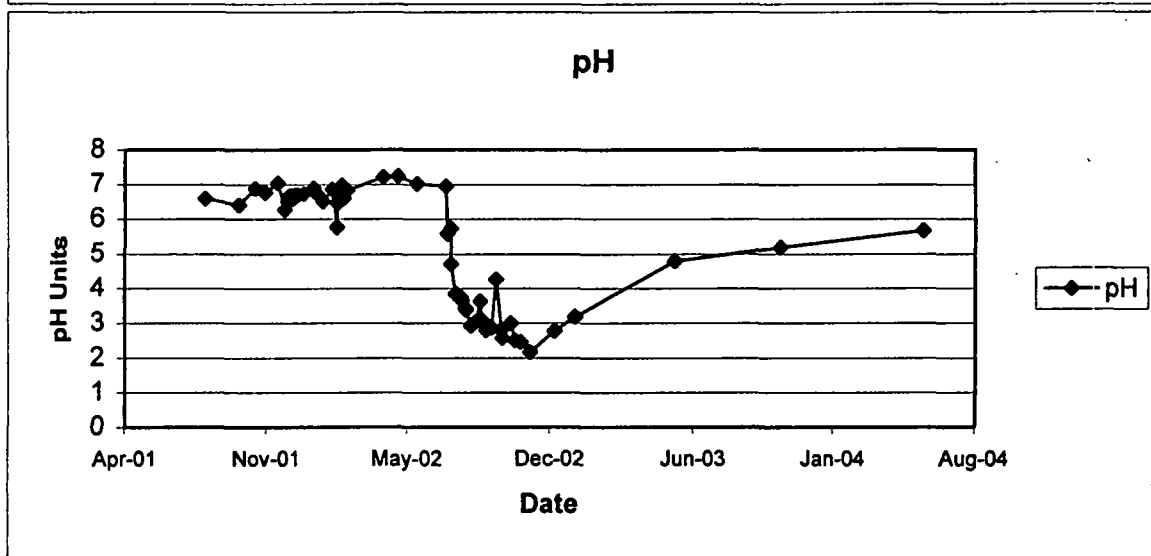
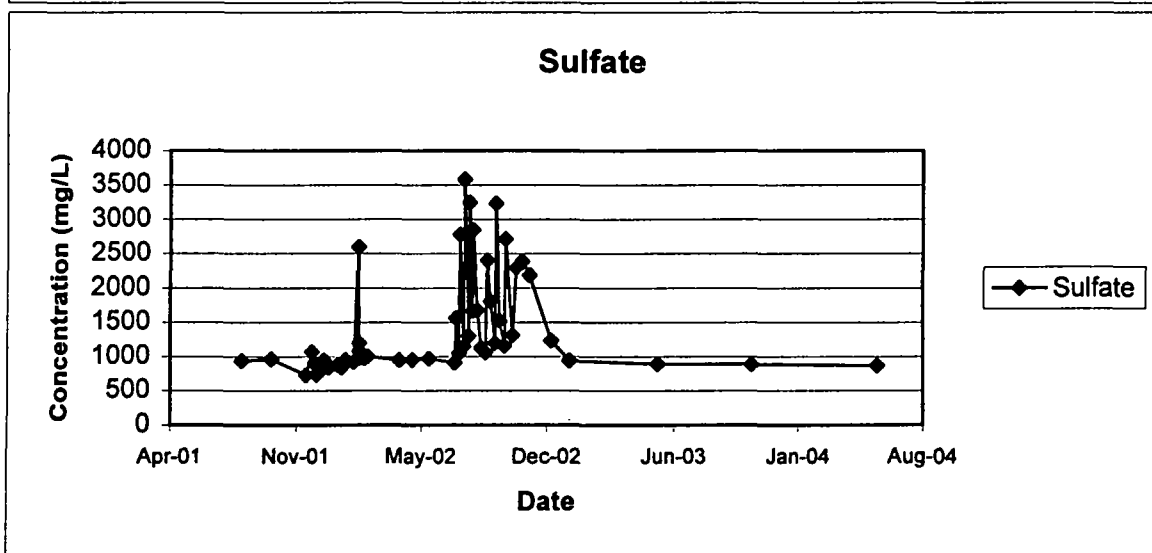
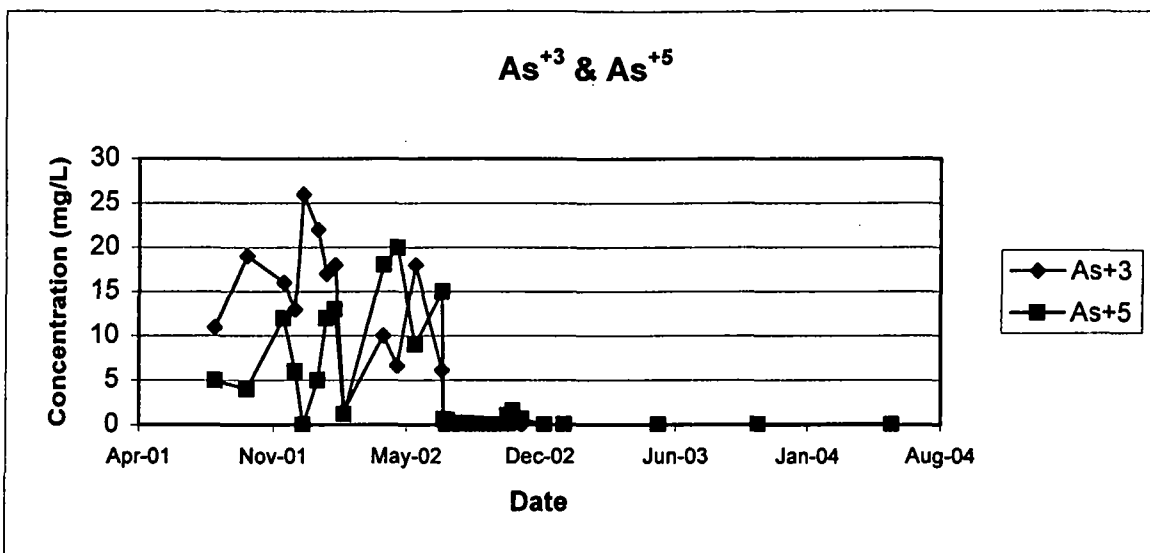
APPENDIX F - STW-6 TREND PLOTS



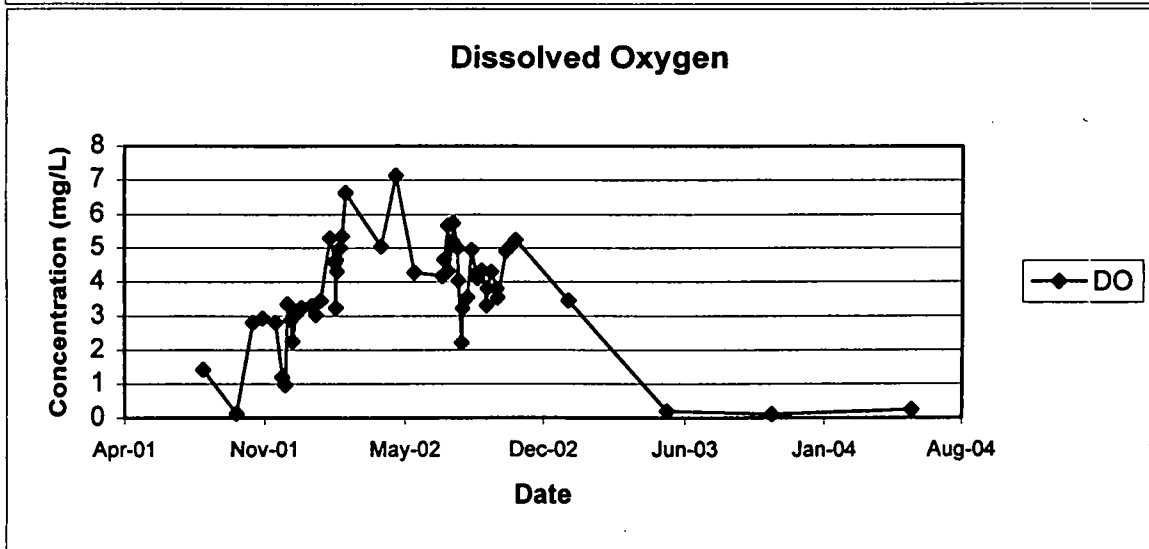
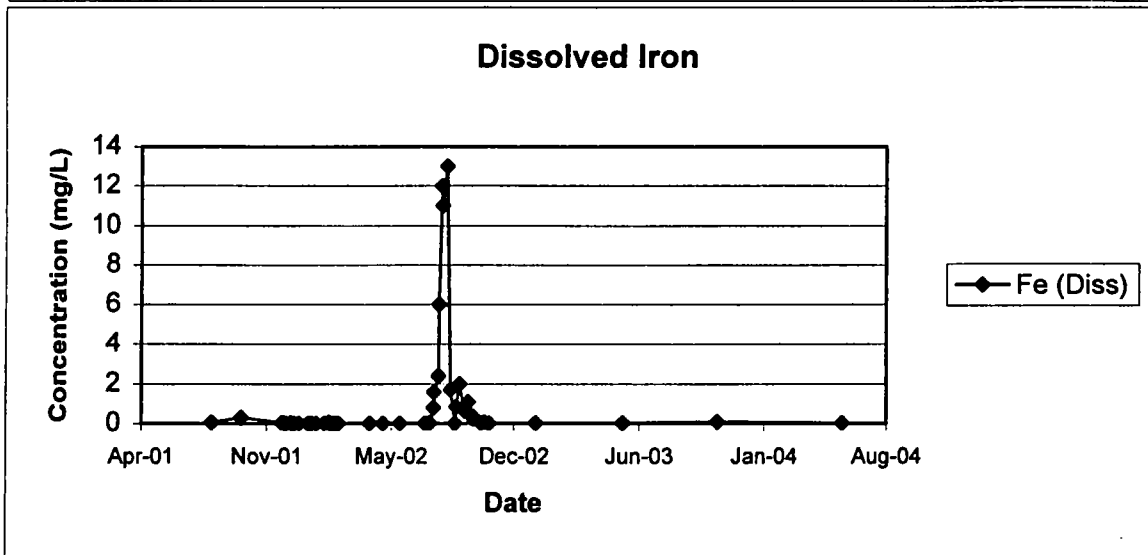
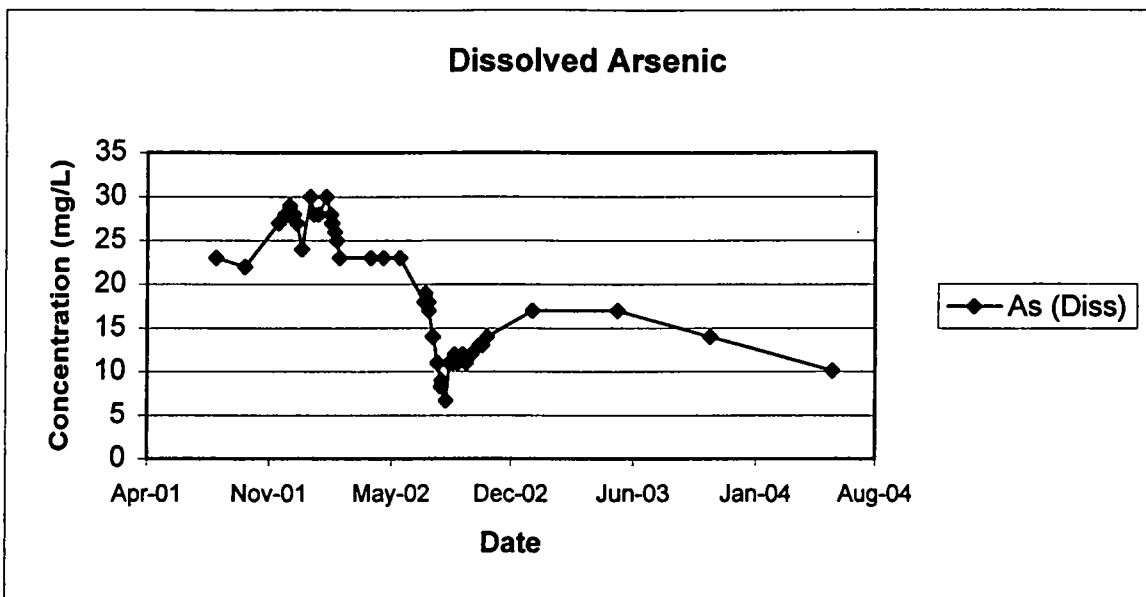
APPENDIX F - STW-7 TREND PLOTS



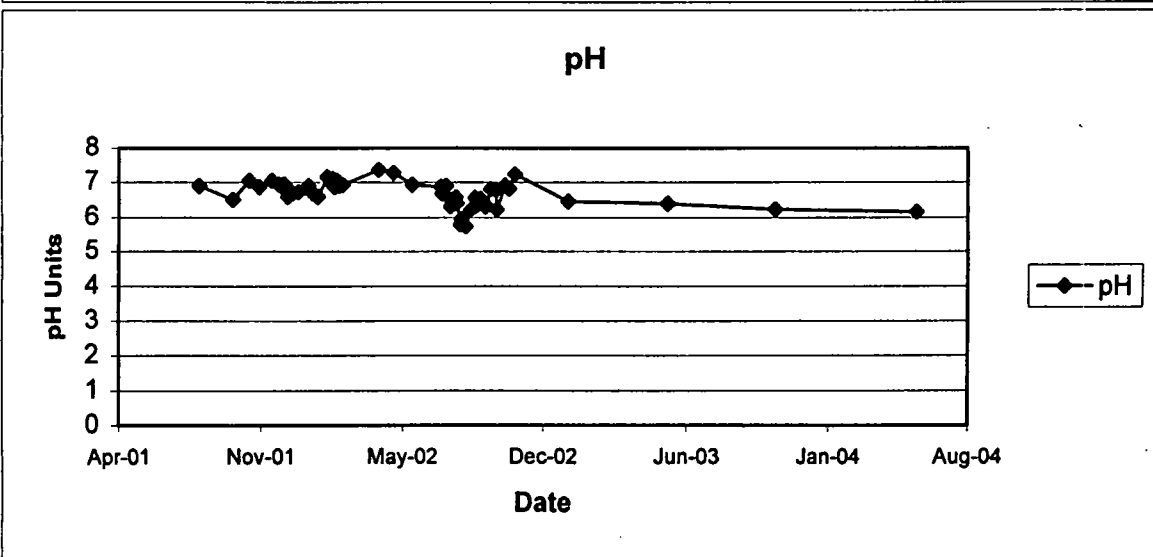
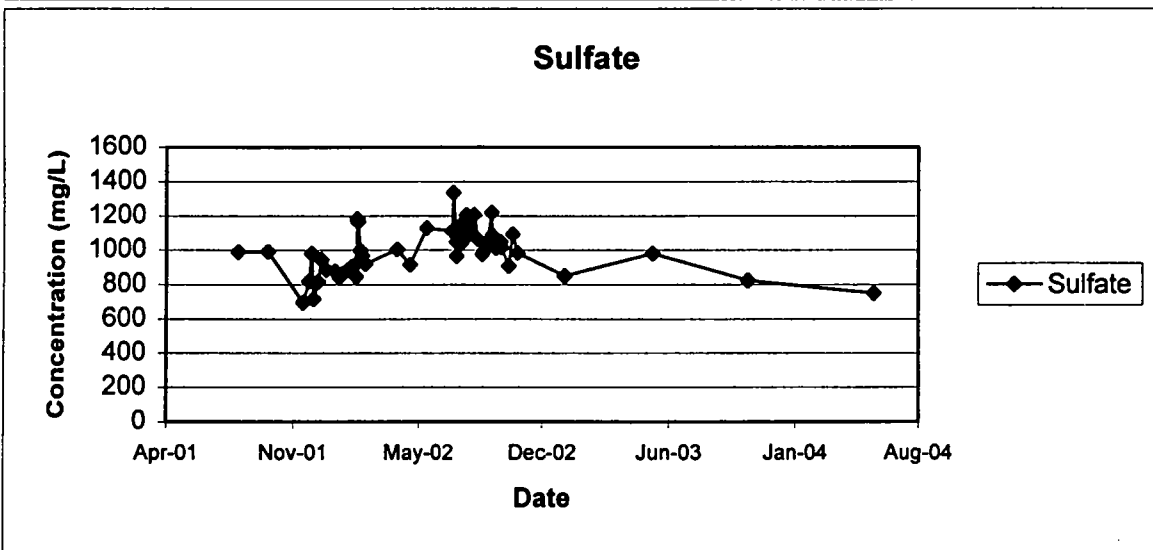
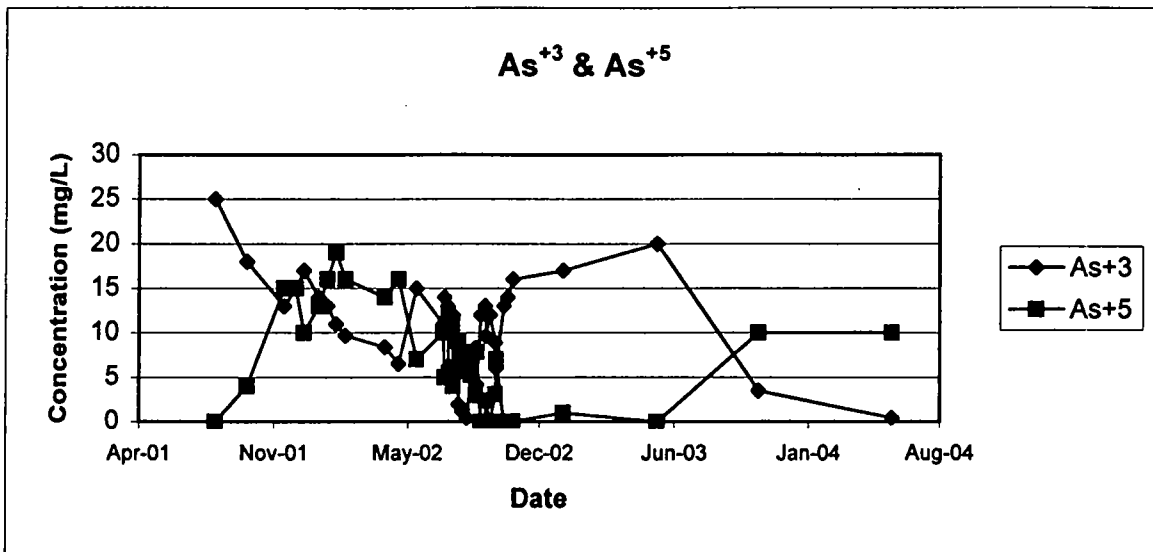
APPENDIX F - STW-7 TREND PLOTS



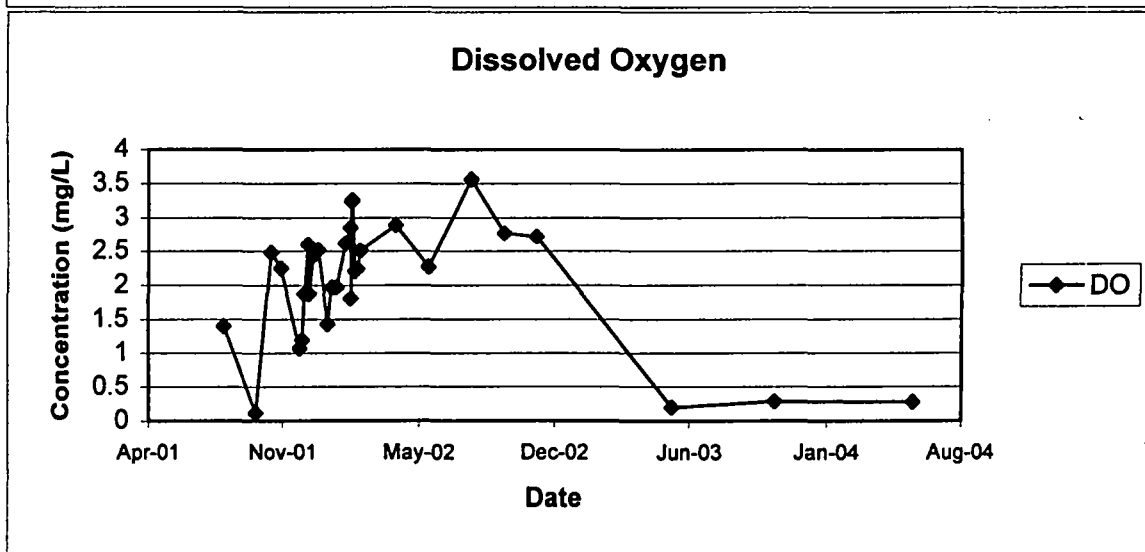
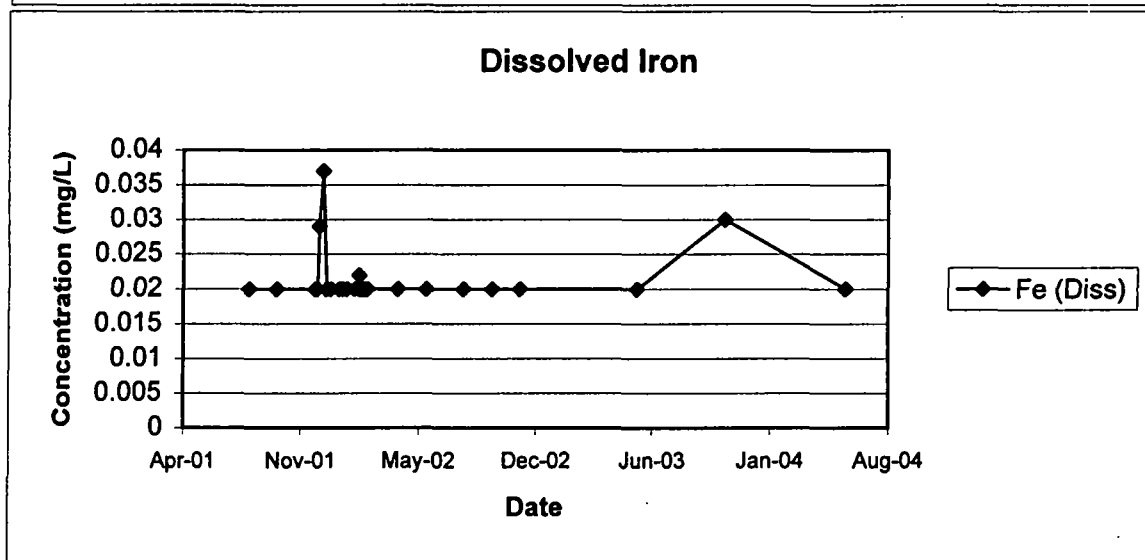
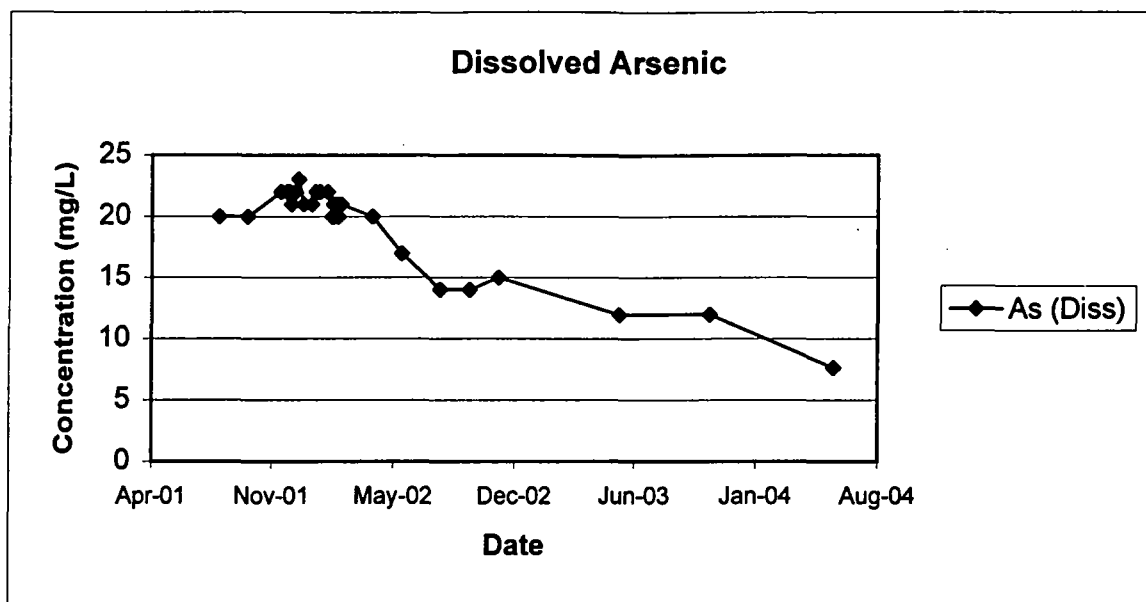
APPENDIX F - STW-8 TREND PLOTS



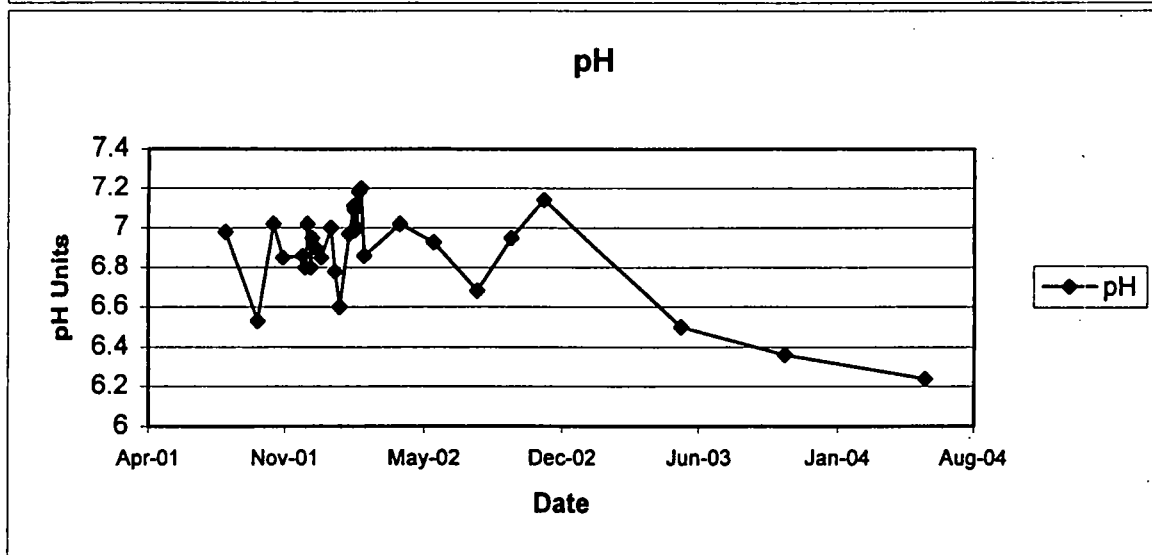
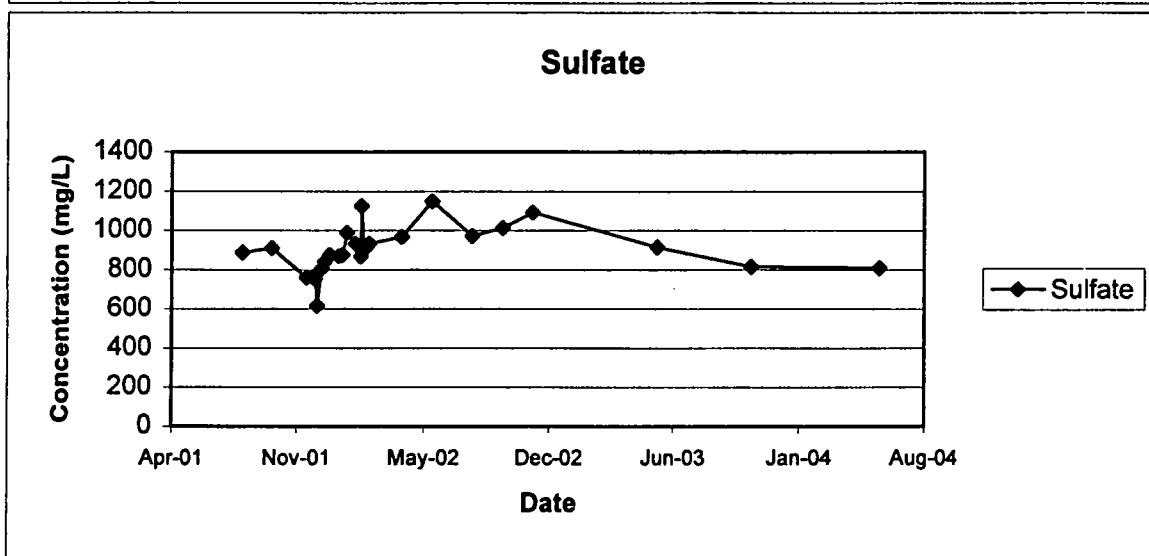
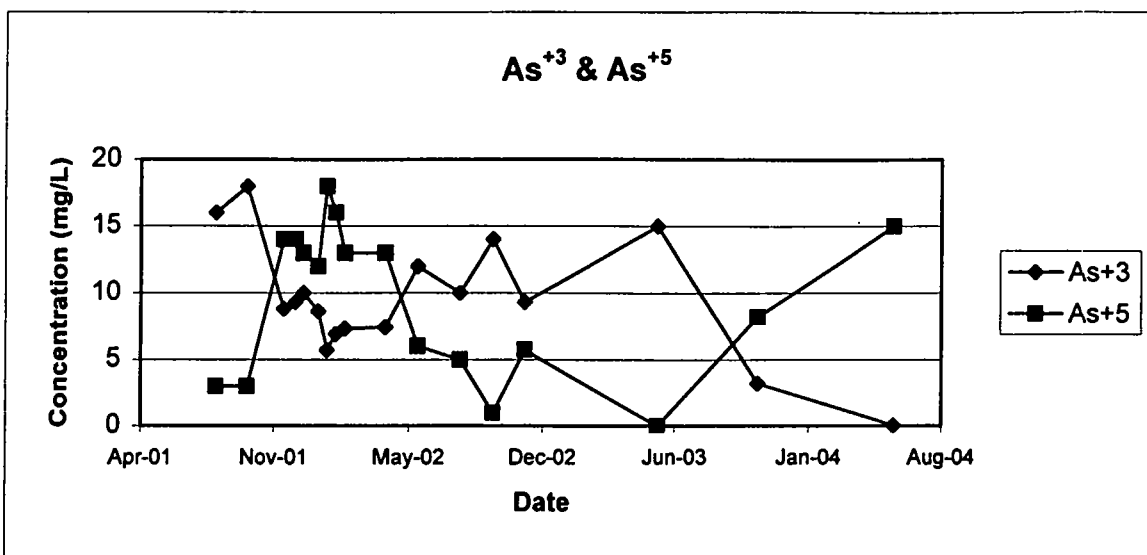
APPENDIX F - STW-8 TREND PLOTS



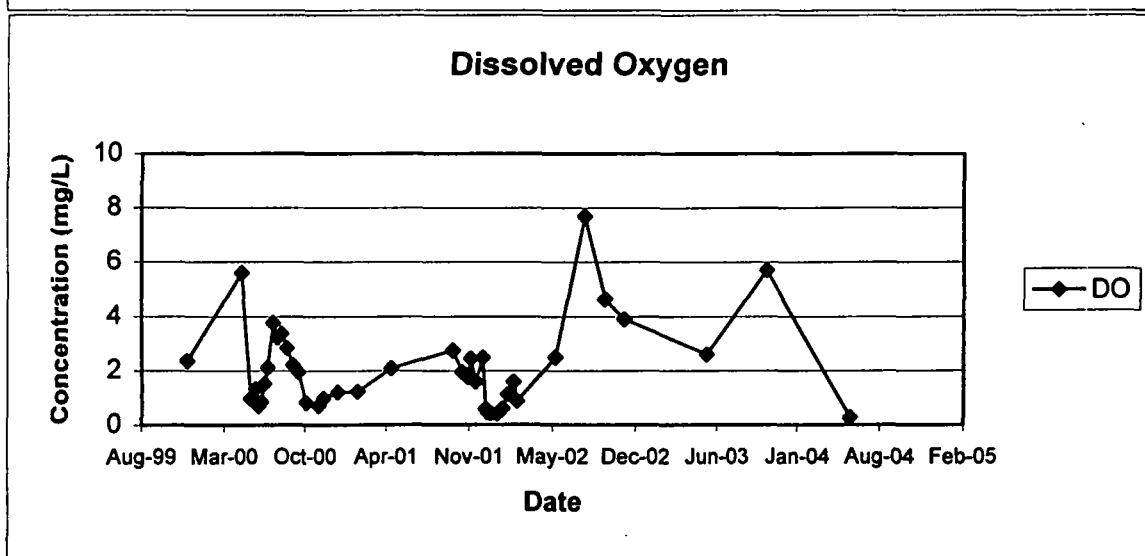
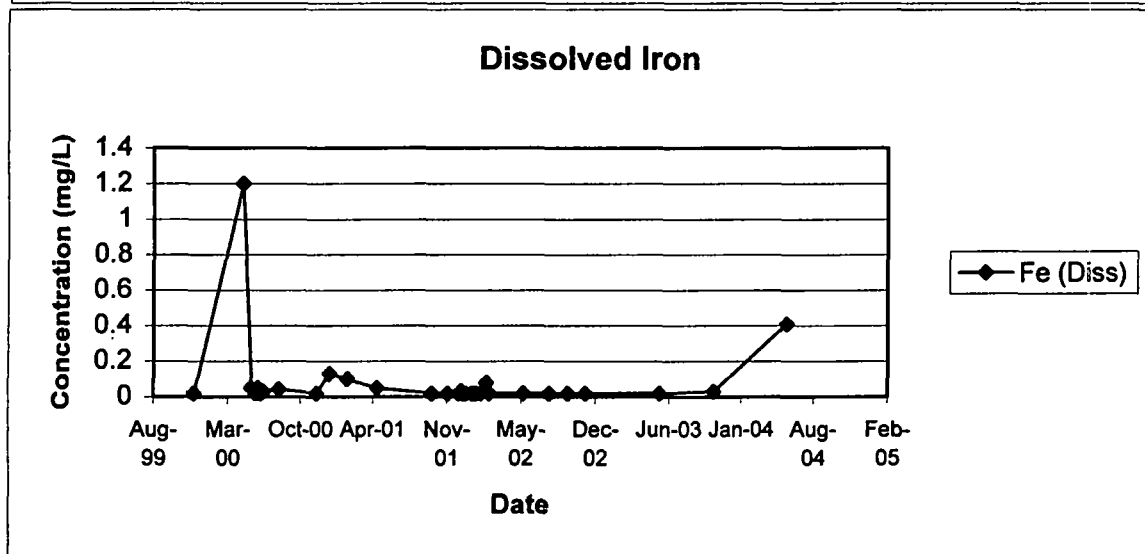
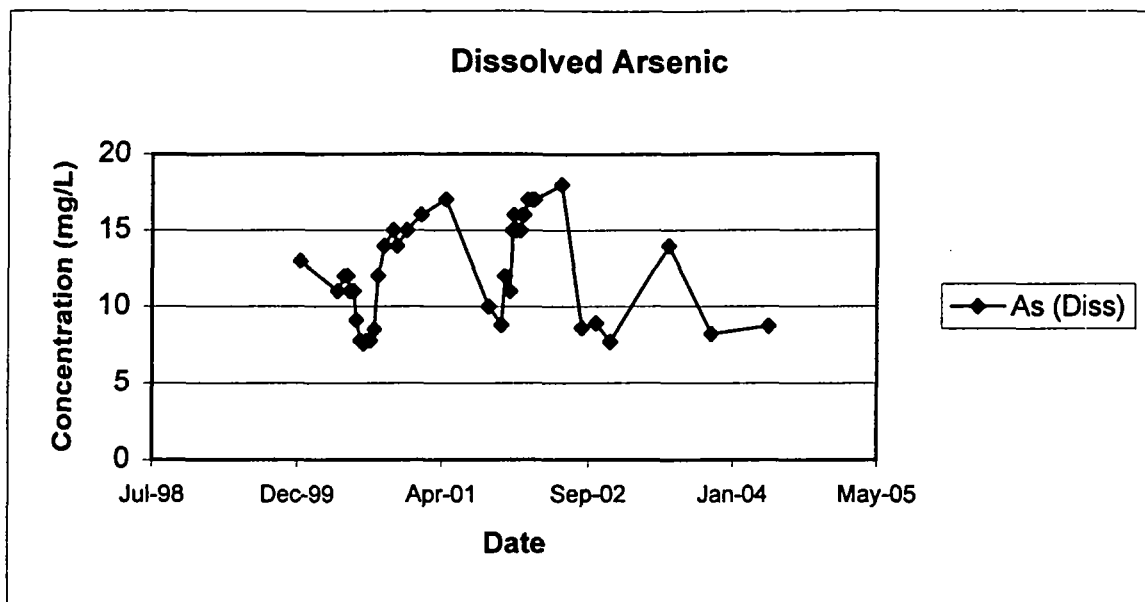
APPENDIX F - STW-9 TREND PLOTS



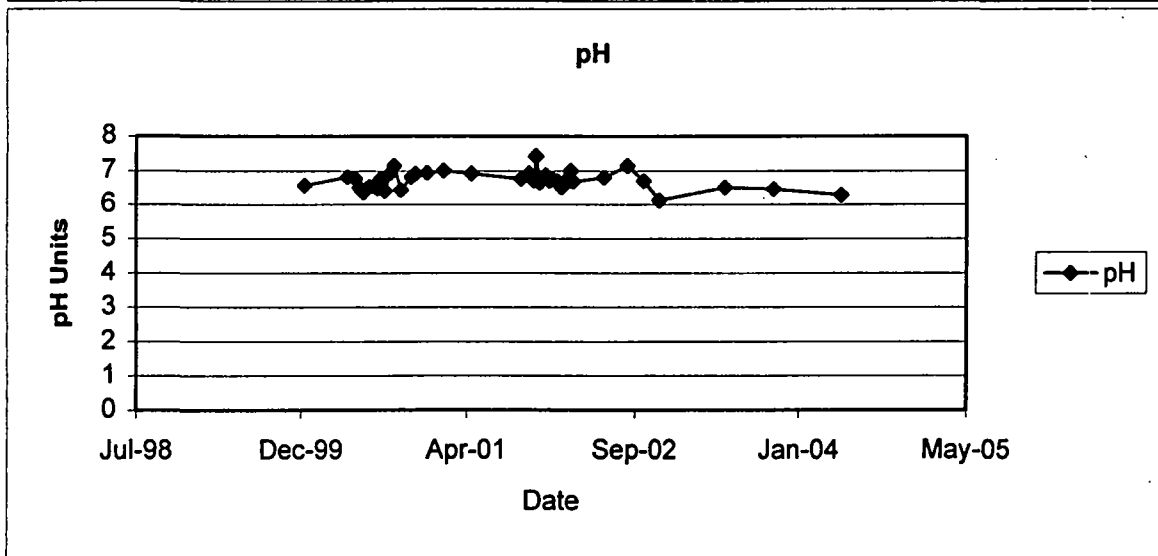
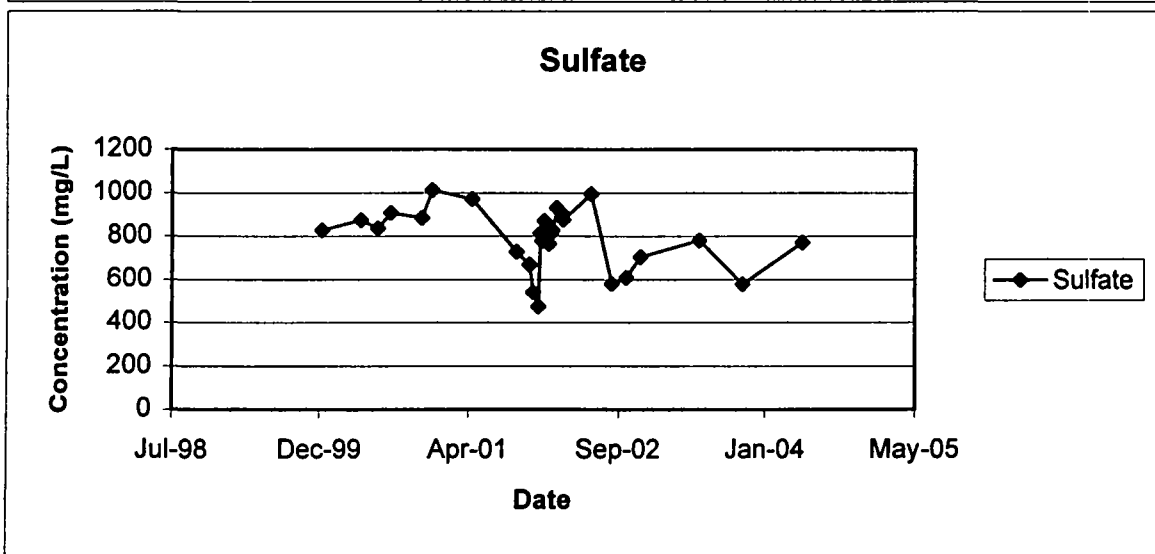
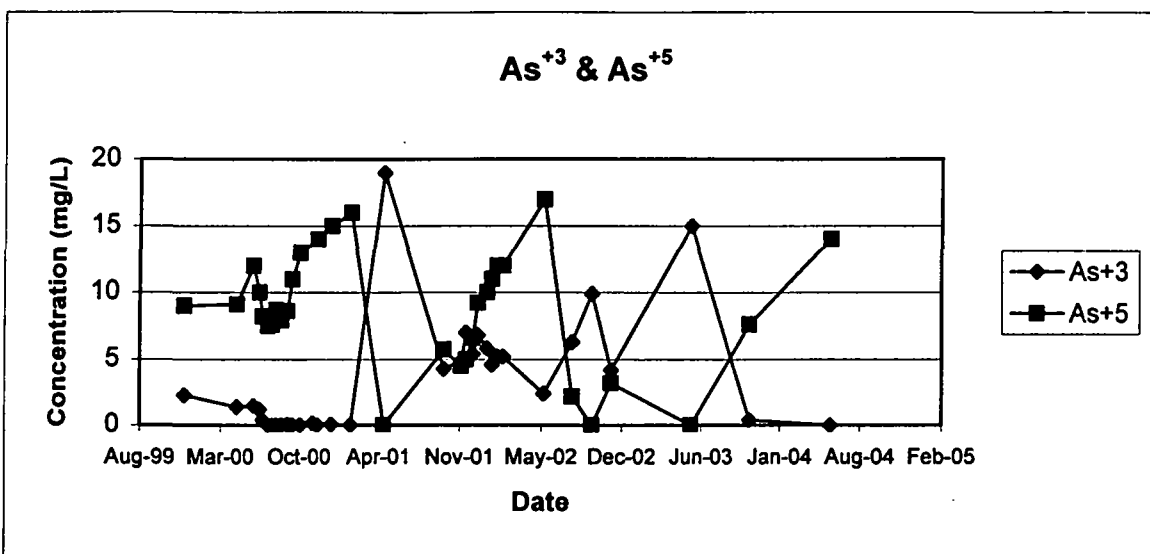
APPENDIX F - STW-9 TREND PLOTS



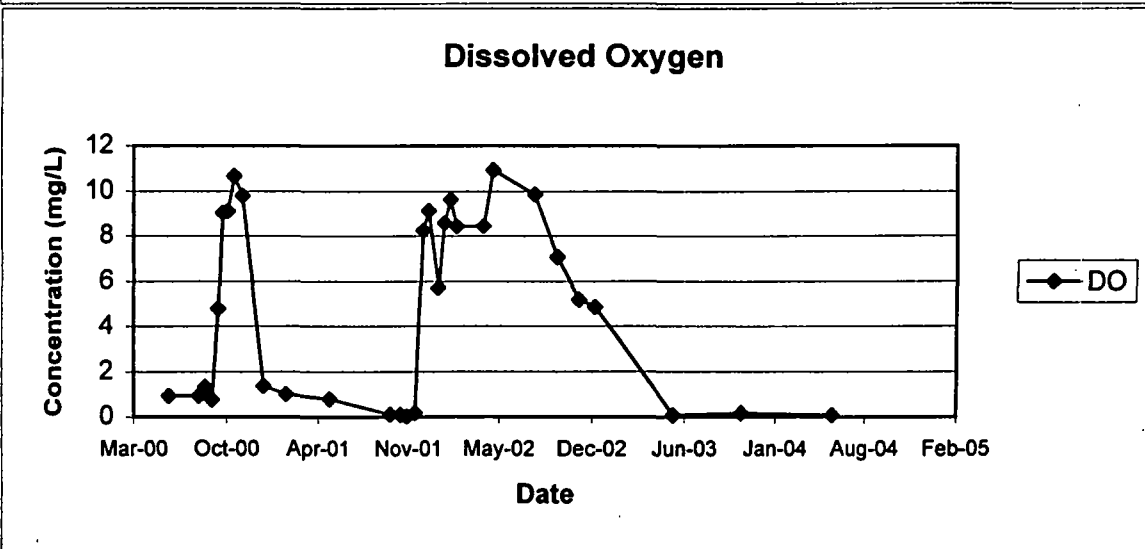
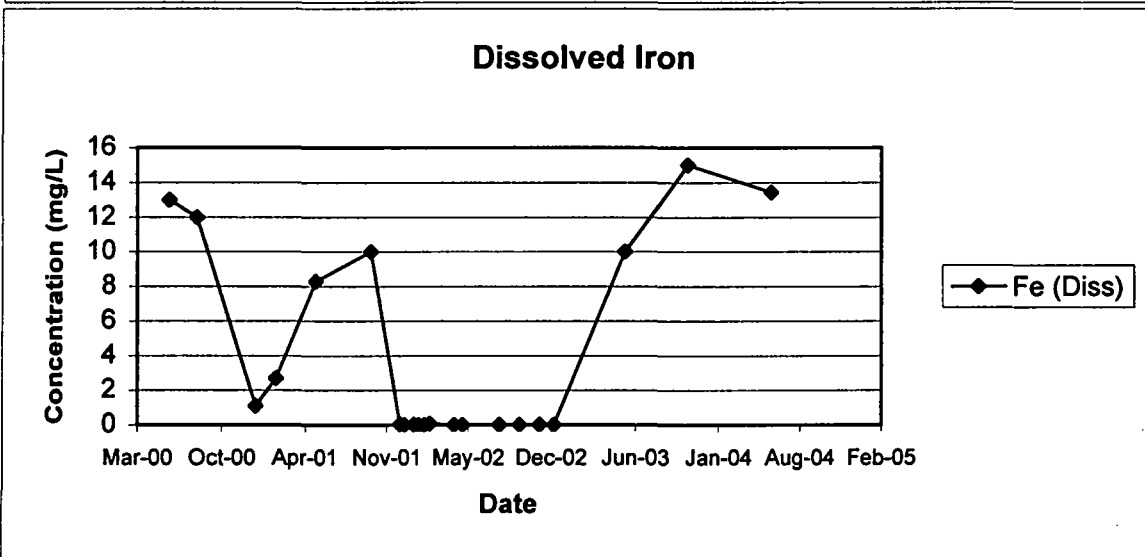
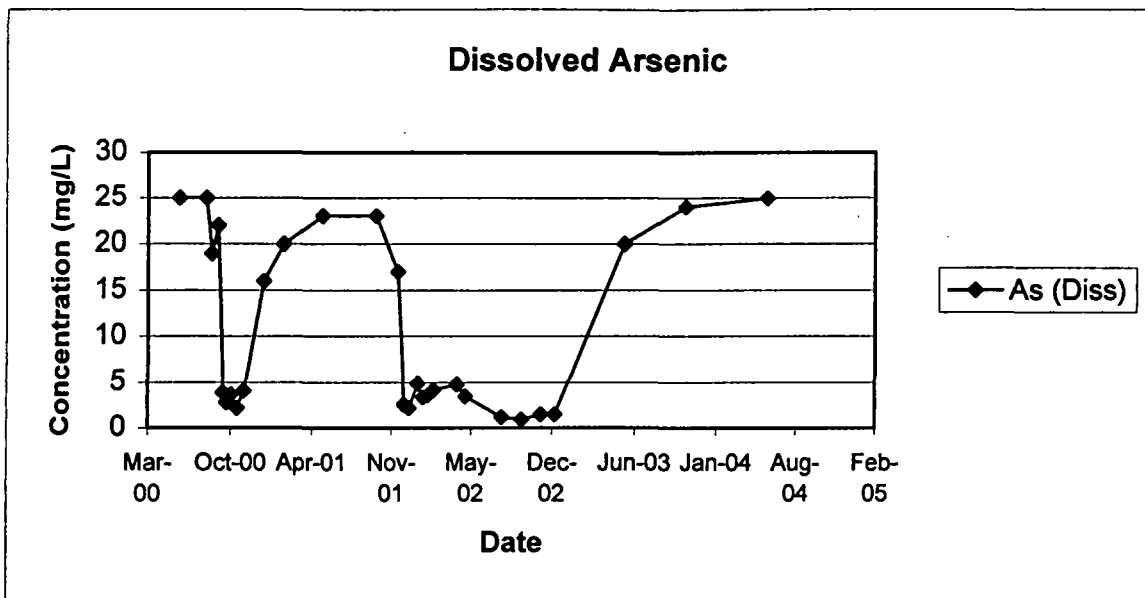
APPENDIX F - DH-50 TREND PLOTS



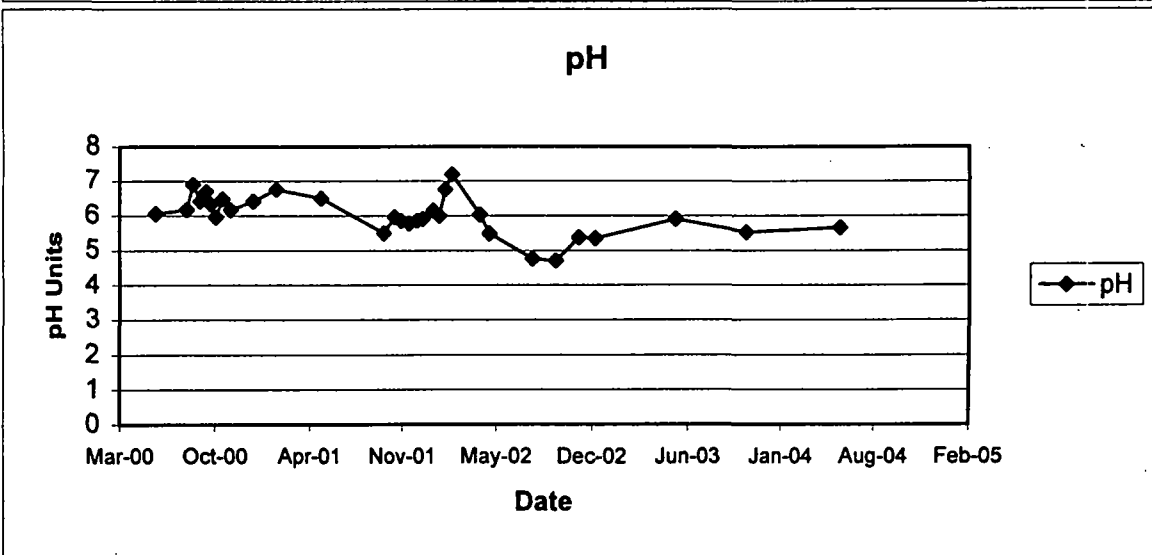
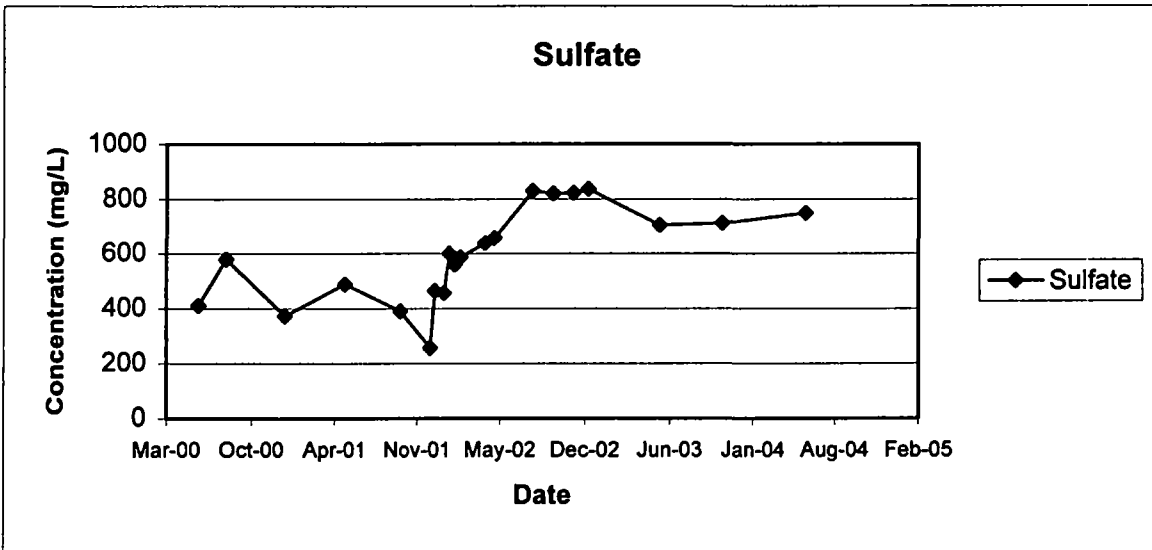
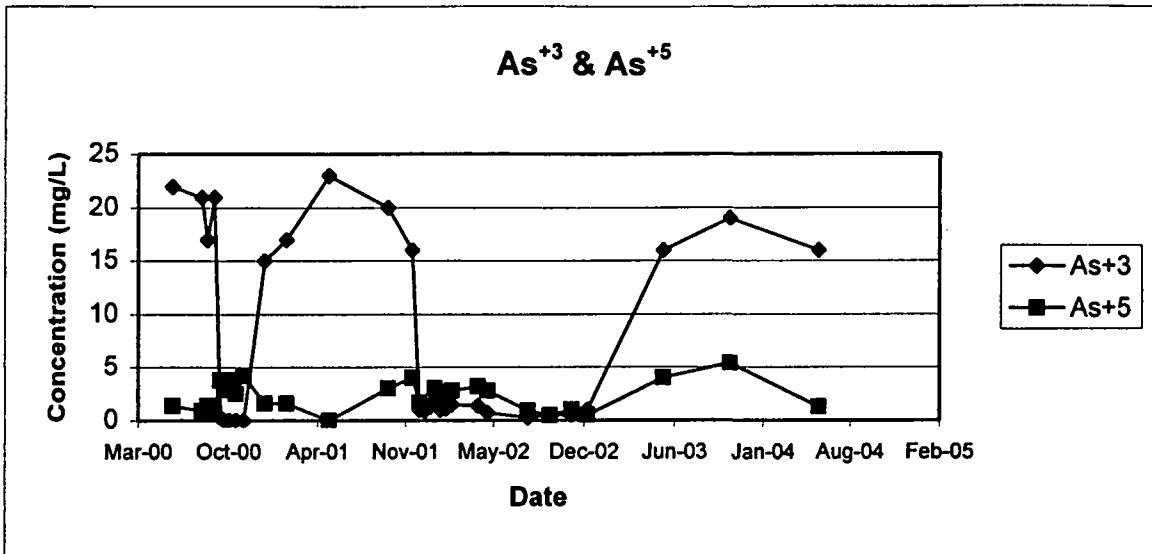
APPENDIX F - DH-50 TREND PLOTS



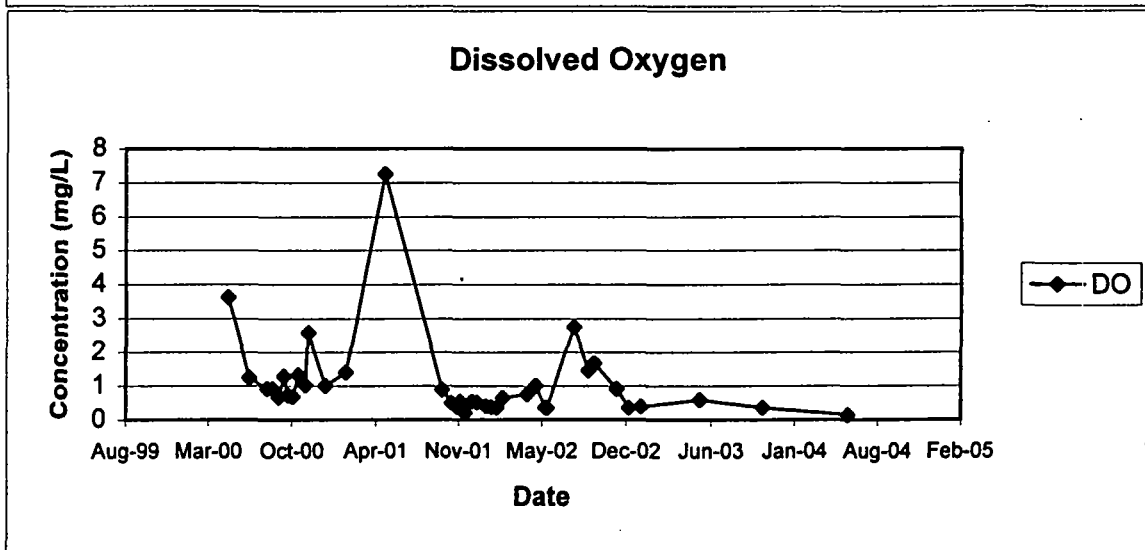
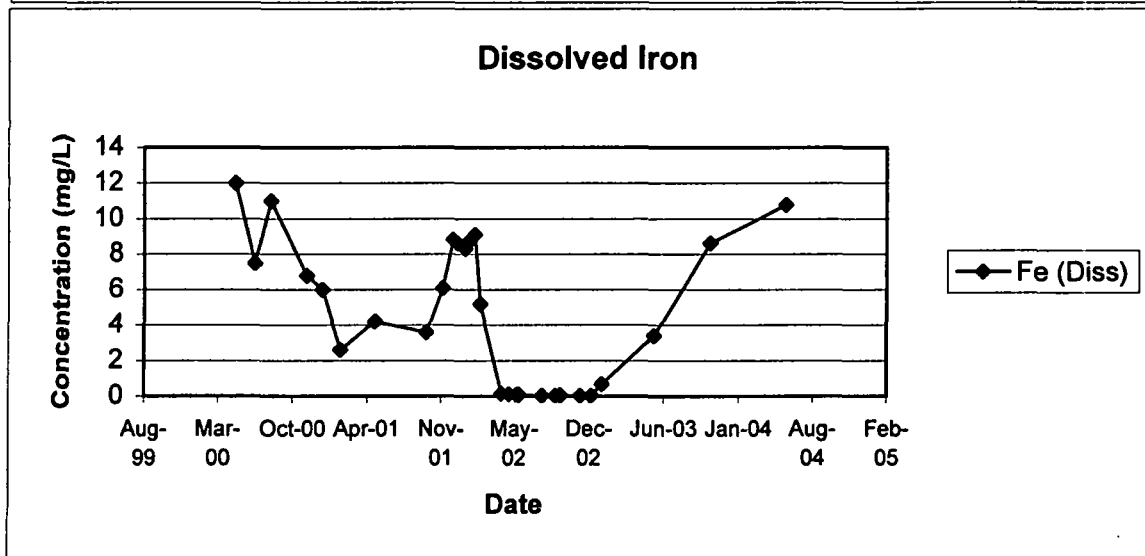
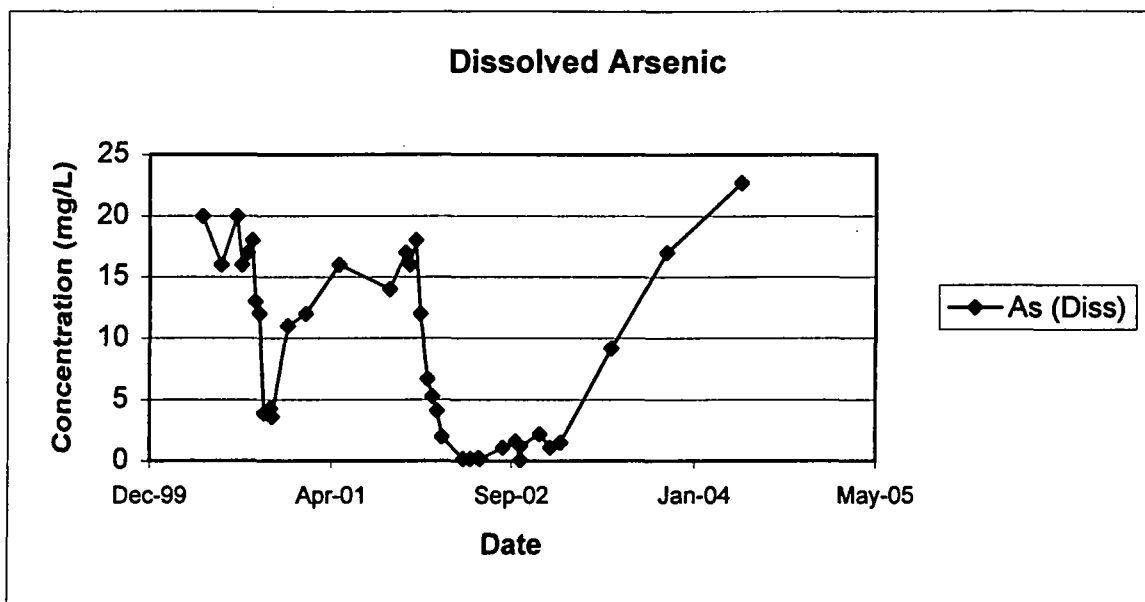
APPENDIX F - SPAR-3 TREND PLOTS



APPENDIX F - SPAR-3 TREND PLOTS



APPENDIX F - DH-24 TREND PLOTS



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APPENDIX F - DH-24 TREND PLOTS

